Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

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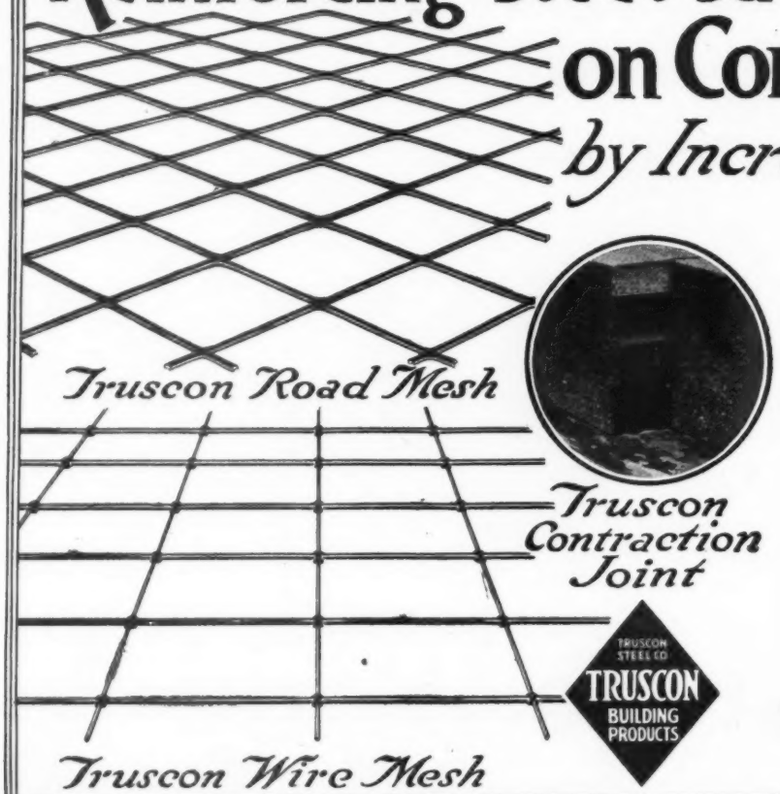

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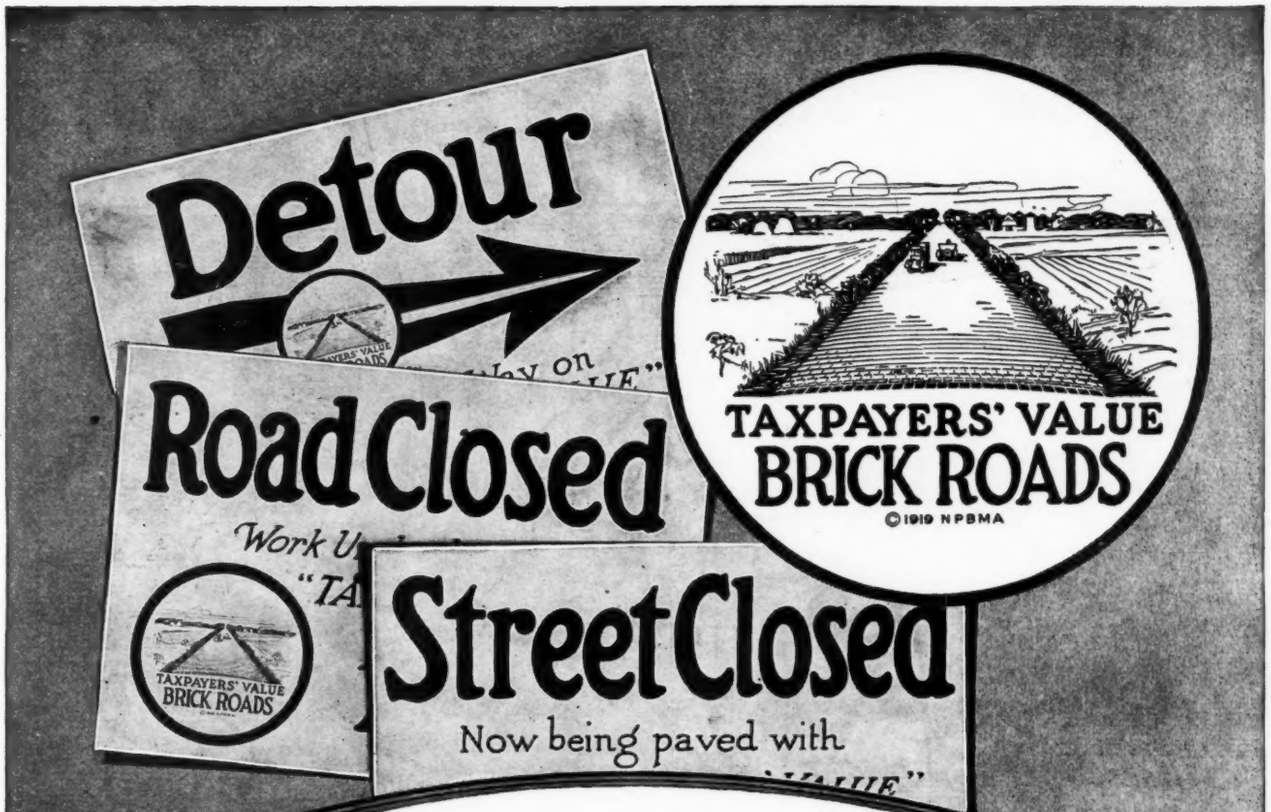

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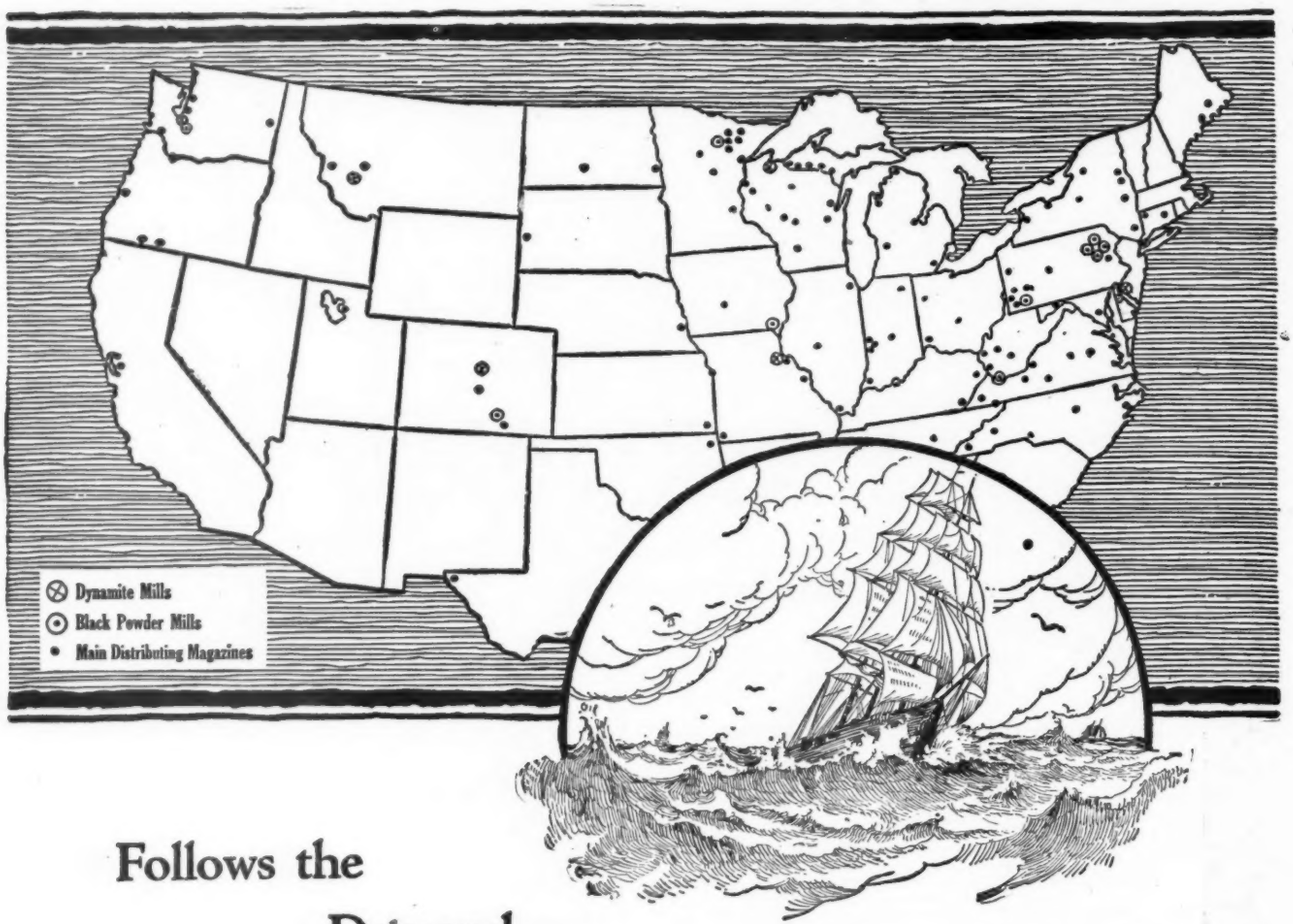

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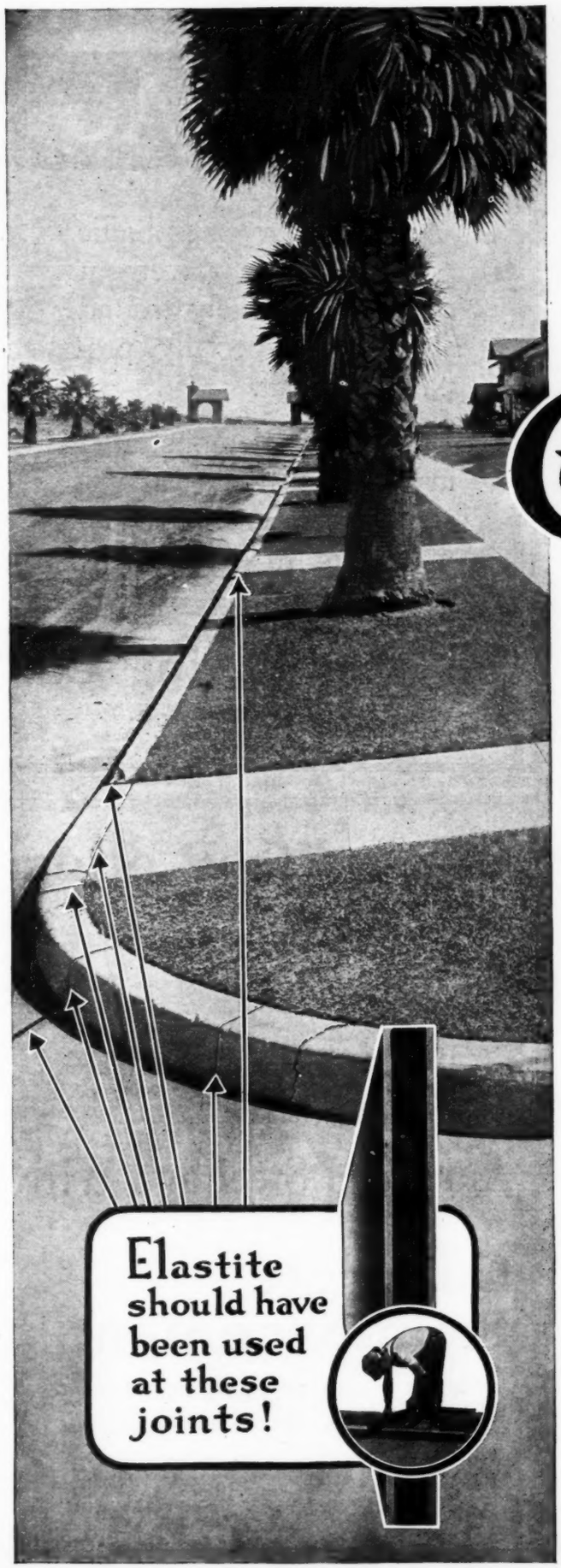

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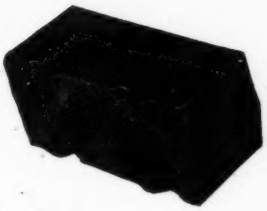

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Hundreds of miles of old macadam roads have been similarly utilized—and thousands more should be. Can we be of assistance? Please write.

METROPOLITAN PAVING BRICK COMPANY
Canton, Ohio

Photo shows Boardman Road, near Youngstown, Ohio. Paved with "Bessemer Block"—a Metropolitan product.

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Koehring Machine Company.
T. L. Smith Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co
Service Motor Truck Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co
Diamond T Motor Car Co.
Federal Motor Truck Co
The Gramm-Bernstein Motor Truck Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.
Service Motor Truck Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
F. C. Austin Machinery Co.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co., The
The Gramm-Bernstein Motor Truck Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.
Service Motor Truck Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry

Paints (Asphalt).
Barber Asphalt Paving Co.
Barrett Co., The

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
Barber Asphalt Paving Co.
The Barrett Co.
Philip Carey Co., The.

Paving Joint Filler.
Barber Asphalt Paving Co.
The Barrett Co.

Paving Machines.
F. C. Austin Machinery Co.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
F. C. Austin Machinery Co.
Barber Asphalt Paving Co.
Cummer & Son Co., The F. D.
East Iron & Machine Co
Good Roads Machinery Co., Inc.
Smith Co., T. L. The.
Warren Bros. Co.

Pipe Dip and Coatings.
The Barrett Co.
The Texas Co.

Pipe Manufacturers.
American Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
F. C. Austin Machinery Co.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Pumps.
Harris Air Pump Company.
Smith Co. T. L. The.

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Barber Asphalt Paving Co
Kentucky Rock Asphalt Co.
Sinclair Refining Company.
The Texas Co

Road Binder.
Barber Asphalt Paving Co.
The Barrett Co.
Sinclair Refining Company.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
F. C. Austin Machinery Co.
Austin-Western Road Machinery Co., The
Barber Asphalt Paving Co
Cummer & Son Co., The F. D.
East Iron & Machine Co. The
Good Roads Machinery Co., Inc.
Mayer, F.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co.

Road Oils and Preservatives.
Barber Asphalt Paving Co.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Barber Asphalt Paving Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Rock and Sand Heaters.
East Iron & Machine Co., The

Roofing Material.
Barber Asphalt Paving Co.
The Barrett Co.
Philip Carey Co., The.
The Texas Co.
Warren Bros.

Sand Dryers.
Cummer & Son Co., The F. D.

Sandstone.
Cleveland Stone Co.
Ohio Quarries Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling and Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.
Electrolytic Sanitation Co.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.

Sewer Castings.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.
Vitrified Pipe Mfrs. Assn.

Sewer Rods.
Stewart, W. H.

Sidewalks (Stone).
Cleveland Stone Co.
Ohio Quarries Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
F. C. Austin Machinery Co.
Good Roads Machinery Co., Inc.

Special Castings.
Crane Co.
Flower Valve Mfg. Co.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
F. C. Austin Machinery Co.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co.

Stone Curbing.
Cleveland Stone Co.
Ohio Quarries Co.

Stone Elevators.
Austin-Western Road Machinery Co.

Stone Flagging.
Cleveland Stone Co.
Ohio Quarries Co.

Stone Spreaders.
Austin-Western Road Machinery Co.
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Crossings.
Cleveland Stone Co.
Ohio Quarries Co.

Street Flushers (Horse Drawn).
Austin-Western Road Machinery Co.

Street Paving Material.
Barber Asphalt Paving Co.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Co., Ltd., The

Structural Steel.
Lewis-Hall Iron Works.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
F. C. Austin Machinery Co.
Austin-Western Road Machinery Co., The
Elgin Sales Corp.

Tamping Machines.
Pawling and Harnischfeger.

Tanks, Water Supply.
Mensch, L. J.

Tar and Pitch.
The Barrett Co.
Philip Carey Co., The.

Tar Heaters.
Littleford Bros.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith
Walter H. Flood
Howard, J. W.
Kirschbraun, Lester
Van Trump, Isaac.

Traction Engines.
Austin-Western Road Machinery Co., The

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
F. C. Austin Machinery Co.

Trench Braces.
Kalamazoo Fdy. & Mach. Co.

Trench Machinery.
F. C. Austin Machinery Co.
Kalamazoo Fdy. & Machine Co.
Pawling and Harnischfeger

Trinidad Lake Asphalt.
Barber Asphalt Paving Co.

Valves.
Coldwell-Wilcox Co.
Crane Co.
Flower Valve Mfg. Co.

Wall Coping.
Cannelton Sewer Pipe Co.

Warrenite.
Warren Bros. Co.

Water Pipe.
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau

Waterproofing.
Barber Asphalt Paving Co.
Barrett Co., The
The Texas Co.
Truscon Steel Co.

Water Purification.
Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

Water Works Supplies and Equipment.
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau
Coldwell-Wilcox Co.
Crane Co.
Flower Valve Mfg. Co.
McNutt Meter Box Co.
Pennsylvania Salt Mfg. Co.

Wheeled Scrapers.
Austin-Western Road Machinery Co.

Winches, Vertical Capstan or Friction Drum.
Mead-Morrison Manufacturing Co.

Wire Rope.
American Steel & Wire Company

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
Springfield Paving Brick Co.

Wood Block (Creosoted).
Barrett Co., The
Republic Creosoting Co.

Wood Preservatives.
Barrett Co., The
Republic Creosoting Co.

MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation

THE SCOOP CONVEYOR
SAVES TIME, LABOR AND MONEY IN STORING AND RECLAIMING, IN LOADING AND UNLOADING CARS, TRUCKS AND WAGONS.
SAVES 6 to 12 MEN.
ENABLES MEN TO WORK FASTER AND EASIER. ELIMINATES MUCH SHOVEL AND WHEELBARROW WORK. DOES THREE TO FIVE DAYS WORK IN ONE.
OVER 2000 USERS
Write for Literature
PORTABLE MACHINERY CO., PASSAIC N.J.

Printed as insert to Municipal and County Engineering, Chicago, Ill., April, 1920.

Motor Truck Operation and Accounting LVI

Interesting letters from satisfied users of motor trucks reach the editor continuously. All cannot be published, but some are given to reflect the satisfaction given by trucks in the municipal and county field throughout the country.

Performance of Diamond T Trucks in Milwaukee

H. W. Parker, foreman of the municipal garage of the Department of Public Works of the City of Milwaukee, submits the following facts and figures about the performance of the three Diamond T trucks in city departments. He has charge of all supplies, materials and repairs required in the operation of all trucks in the garage, numbering 61. He writes:

"We are operating three 2-ton Diamond T trucks, our Nos. 39, 48 and 49 all making short hauls entirely within the city limits.

"Truck number 39 was purchased in July, 1918. Since that time it has been in operation every day except Sundays and holidays, doing heavy and light work. Miles traveled, 6,399. Gasoline used, 1,008 gals. Average miles per gal,, 6.05. Motor oil used, 104 qts. Average miles per qt., 58.6. Greases and labor of greasing and adjustments plus cost of gasoline and oil, $330.31, or an average cost of 0.0541 cts. per mile, ending March 1st, 1920, covering a period of 20 months.

"Truck number 48 was purchased in March, 1919. Miles traveled, 3,617. Gasoline used, 775 gals. Average miles per gal., 4.66. Motor oil used, 10.3 qts. Average miles per qt., 35.1. Greases and labor of greasing and adjustments plus cost of gasoline and oils, $278.80, or an average cost of 0.0779 per mile.

"Truck number 49 was purchased in March, 1919. Miles traveled, 4,426. Gasoline used, 909 gals. Average miles per gal., 4.86. Motor oil used, 161 qts. Average miles per qt., 27.4. Greases and labor of greasing and adjustments plus cost of gasoline and oils, $326.34, or an average cost of 0.0737 per mile.

"In other words, the three 2-ton trucks combined have cost the City of Milwaukee an average of 0.0683 cts. per mile to operate. No repairs have been made on any of these trucks during this period of time, nor have they been laid up for a single hour's repair. Filling with gasoline, oils and greasing, etc., is done nights.

"These figures, you will notice, do not cover minor overhead expenses, insurance and depreciation."

Using Trucks to Haul Sand and Gravel

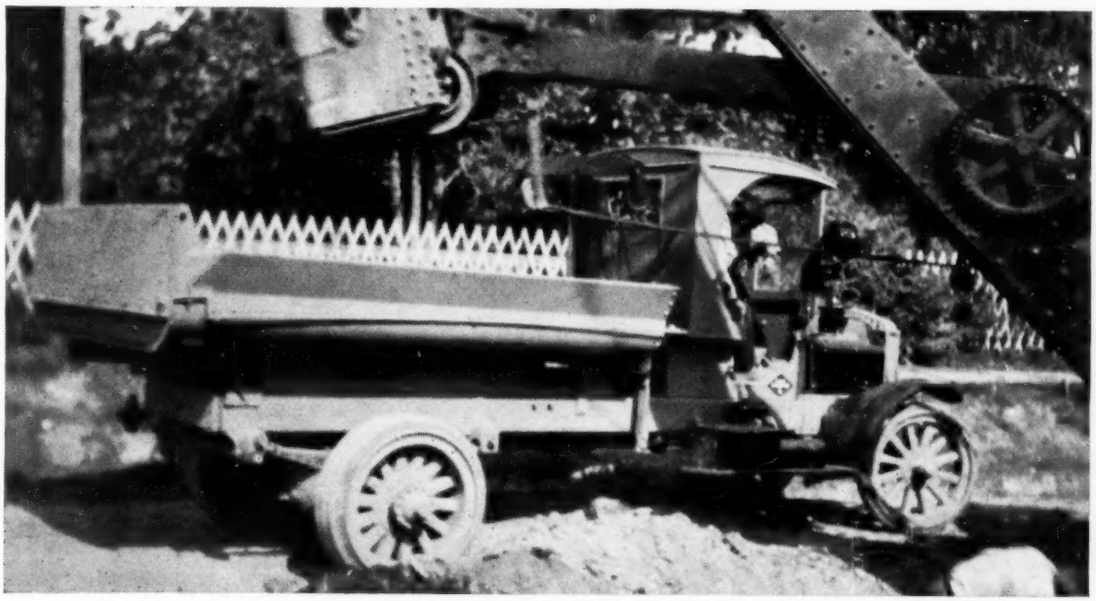
Mr. R. Snoddy, Manager of the Coon River Sand Co., Des Moines, Ia., has made a careful study of truck economics in his business and has written an interesting letter. He says:

"We have been using motor trucks in delivery for about eight years. For a long time conditions were unsatisfactory, we having no pavements to our plants, which were in the river bottoms and much of the season the road was impassable for trucks. Five years ago we paved the roads to our plants and installed overhead loading chutes, but did not increase our truck equipment for the reason that up to that time they had not proved profitable and had given poor satisfaction. However, inasmuch as we had four trucks on hand, we concluded to use them up but not to buy more. The addition of the paved road to our plant, however, made quite a difference. We saw readily that our own trucks were more satisfactory even though by this time they were virtually junk. We started with trucks back in the days when the American Locomotive Company built the Alco truck. Everyone knows there was never a better truck put on the market, but they became old and worn and would not satisfactorily handle the inferior gasoline.

"More than 50 percent of the sand and gravel we sell is hauled from our plant by the customer. We observed in the last few years that trucks became very numerous and we kept check for two seasons on what other people were doing with their trucks and watched to see what make of truck was giving satisfaction. We realized soon that to hold our supremacy in the retail business in this city against our competitors it would be necessary to "ditch" all of our old trucks and put on something up-to-date. We have never owned a team of horses. We have always paid for our delivery on a zone system. Last summer when we were working as many as 20 to 25 teams and from 10 to 15 trucks, paying them on this zone system, we found that the boys driving the 2-ton trucks were earning from $30 to $35 per day and the 3½-ton trucks going to as high as $45 per day on the same rate of pay per zone that we were paying to teamsters who were making from $8 to $9 per day. Summing up the information we had obtained by keeping check on the hired trucks for two years, we readily could see the advantage of owning our own machines, provided they were up-to-date and good ones.

"So, last summer we put in an order for one-half dozen Master trucks, some equipped with Lee side-dump bodies and others with the rear dump hydraulic. On the rear dumps we use the Heil twin-cylinder underslung hoist, which we have found to be not only very good in its work, but it is out of the way and takes up no room back of the seat, no chains or wire cable or anything else to break and get out of order and a very simple drive. In other words, they just hoist anything you put on the truck and make no noise about it. We put these trucks to work last fall and they were a wonderful success. We, of course, have not owned Master trucks long enough to be able to give a life history, but we do know much about them from watching others use them for hauling from our plants.

"We find that the truck does not deliver sand and gravel a great deal cheaper than teams, but the big advantage is that they enable us to give service and to cover a large territory. A few weeks ago a contractor wanted a carload of material quickly at a station on the interurban about nine miles out. It is difficult to get the use



DIAMOND T
"The Nation's Freight Car"

A Record that Broke Records

UNDER a steam shovel, night and day; with a 10-mile haul over ruinous "highways"; moving 80 tons a day for six solid months; 5,000 miles in all—

And not one cent for repairs!

Sounds like a fairy tale, doesn't it? But it is an actual-fact record of **Diamond T** *heavy-duty* performance for the Canadian Government—road construction on Vancouver Island, near Victoria.

Remarkable, yes. It is typical, however, of **Diamond T** performance throughout the world. Owners' records by the score reveal performance no less striking.

There are sound structural reasons—based on 15 years of successful manufacture; a decade devoted to trucks exclusively. The first **Diamond T** truck is still in service—and the design has never been changed except for the better.

Get a line on our new 5-ton Special, Model S, and its unique features—full description sent on request.

A Complete Line: 1½ to 5 tons.

Diamond T Motor Car Co.

4564 West 26th St. CHICAGO, ILL.

of railroad cars for sand shipping in the winter time and the best we could promise was about a week for making delivery. However, two of the little Master trucks took this material out to him in less than two days. Counting the trucks at $30 per day, we found it did not cost any more for the material delivered on the job than if we had shipped it by rail.

"The records which we keep on our trucks consist of gasoline, oil and greases, repair parts, time used in our own garage for repairs and drivers' time, which comprises upkeep. To this we add depreciation. Against this we "butt" what the trucks earned on our zone system of paying for deliveries."

Hall Trucks in the Construction Field

H. W. Herring, Surveyor of Yamhill County, McMinnville, Oregon, writes that his county has two Hall trucks in service. He says: "The Halls have given good satisfaction and the Court says that if they were in the market for more trucks they would buy Halls. We find that for hauling crushed rock and gravel the trucks are far cheaper than by team, as teams are hard to get and cost $1 per hour. We use a Yuba tractor for pulling the scarifiers and graders and use the trucks also to pull the drags."

Mr. R. A. Burns, City Engineer of Lewiston, Idaho, writes that his city has a Hall truck which has been in operation for several weeks in flushing and sprinkling streets. He states that it has been his observation that hauling can be done by trucks at a saving of from 1/3 to ½ the cost of hauling with horses.

Mr. E. Milton Christensen, Highway Engineer of Bingham County at Blackfoot, Idaho, reports the use of two Hall trucks which have given good service. He advises that the economy in the use of trucks is for hauls exceeding three miles.

Mr. W. R. Rehorn, City Engineer of Walla Walla, Washington, reports the use of a Hall motor truck by that city on street flushing. The truck does not have any steady work or fast driving and all of its work is on paved streets. Both Mr. Rehorn and the driver of the truck state that it has not given any trouble. It has not needed any repairs and has given entire satisfaction.

Mr. L. G. Kruel, Secretary of the Washington Special Road District of Franklin County at Washington, Missouri, reports that the Duplex truck operated by the district has rendered the best of satisfaction and has done more than was claimed for it. He states that motor haulage has effected a saving of 50 per cent. in the work of the district in comparison with horse haulage, the largest saving, of course, being on the longer hauls.

Using the Burch Stone Spreader

The George S. Mellert-Weidner Company of Medina, Ohio, report the successful use of a Burch stone spreader, a device attached to the rear end of a motor truck body for distributing stone evenly over the surface of a road. They used the spreader on four miles of three course bituminous bound road, 16 ft. wide on the Wooster pike in Brunswick, Medina County, Ohio. They say that with a properly prepared subgrade and a competent man to operate the spreader it has more than paid for itself on the first four miles of road.

The Galion Construction Company of Galion, Ohio, advise that they have used the Burch spreader on macadam work and find that it saves 50 per cent of the labor in spreading. As the use of the spreader enables the builder to spread stone more uniformly than by hand, a saving in material is thereby effected and amounts to from 5 to 10 percent.

Mr. H. E. Barber, General Superintendent of the Meyer and Meyer Corporation, general contractors, of Lancaster, New York, advises that they have used the Burch spreader on about 15 miles of waterbound macadam and believe that it is a great labor saving device. Their experience shows that 4 men with the spreader can easily handle the work of 20 men without it.

F. E. Lawrence, of the Lawrence Construction Company, general contractors of Augusta, Georgia, reports the use of a Trailmobile for hauling concrete material on city work. They find that it gives excellent service and, if the roads are good so that a trailer can be used, it is decidedly economical. They state that a trailer cannot be used on bad country roads as the 3½-ton trucks which pull them have not the traction to pull them out of holes and thus obtain effective service. For street work and for reasonably good country roads, trailers are highly recommended by this construction company.

Performance of Velie Trucks

Mr. Robert L. Hoffman, Commissioner of the Department of Public Service and Chief Engineer of the City of Cleveland, Ohio, advises that the Bridge Department of Cleveland has used a Velie 3-ton truck in hauling lumber and other structural material for about four years and that it answers the purpose for which it was purchased.

Mr. F. W. Cappelen, City Engineer of Minneapolis, Minnesota, advises that his city bought two Velie trucks seven years ago for the Sewer Department. The engine on one of these trucks was replaced after five years' run, and on the other, after six years' run. The trucks are still doing business and have been quite satisfactory. They haul material used in the work of the Sewer Department.

Use of Armleder Trucks in the Construction Field

The Newcomb Construction Company, Newcomb Boulevard, New Orleans, Louisiana, report the use of an Armleder truck for about six months and say it has given perfect satisfaction. They haul all sorts of building material, including lumber, gravel, cement and form material. In fact, they haul everything used in the construction of high class residences, in which business they are engaged. Mr. John Petrossi, President of the John Petrossi Company, contractors, 112 Livingston Building, Rochester, New York, also reports entire satisfaction with the Armleder truck.

The Portland Contracting Company, Pottsville, Pennsylvania, specializing in rock and tunnel work and in shaft-sinking, report the purchase of an Armleder truck in May, 1919, and advise they have used it on some very heavy work with practically no repairs and have received satisfactory service from it.

Wagner Brothers, of Parkville, Maryland, are engaged in all kinds of contracting work and report satisfactory service from the Armleder truck and especially commend its large capacity. They frequently carry an overload of 2½ tons. They say that the truck has more power in its Continental motor than is really needed.

The Barrett Engineering Construction Company, of

MEAD-MORRISON SERVICE

LIFTS THE LOAD OF INDUSTRY

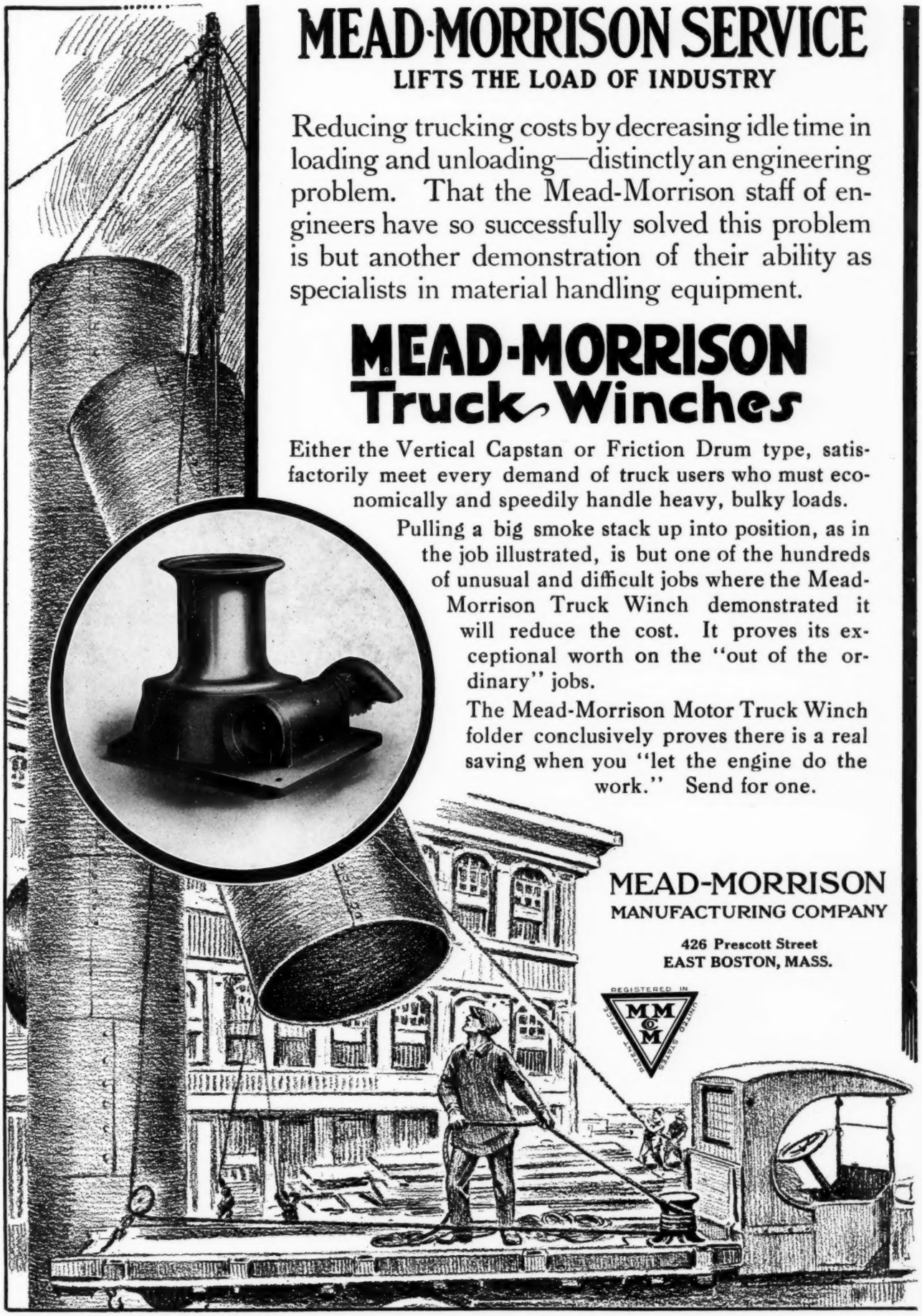
Reducing trucking costs by decreasing idle time in loading and unloading—distinctly an engineering problem. That the Mead-Morrison staff of engineers have so successfully solved this problem is but another demonstration of their ability as specialists in material handling equipment.

MEAD-MORRISON Truck Winches

Either the Vertical Capstan or Friction Drum type, satisfactorily meet every demand of truck users who must economically and speedily handle heavy, bulky loads.

Pulling a big smoke stack up into position, as in the job illustrated, is but one of the hundreds of unusual and difficult jobs where the Mead-Morrison Truck Winch demonstrated it will reduce the cost. It proves its exceptional worth on the "out of the ordinary" jobs.

The Mead-Morrison Motor Truck Winch folder conclusively proves there is a real saving when you "let the engine do the work." Send for one.



MEAD-MORRISON
MANUFACTURING COMPANY

426 Prescott Street
EAST BOSTON, MASS.

REGISTERED IN U.S. PATENT OFFICE
MM&M

Scranton, Pennsylvania, operate a 2-ton Armleder truck equipped with a hydraulic hoist in hauling sand, cement and stone, and with a trailer to haul lumber. They find that the truck stands up well and gives excellent satisfaction. J. T. Elliott, of the State Construction Company, of Indianapolis, Indiana, reports satisfactory service from an Armleder truck for four years.

Mr. R. W. Merritt, of Winchester, Kentucky, operates a 3½-ton Armleder truck and advises that it has been used very hard. He seldom hauls less than 5 tons at a load and has hauled as high as 8 tons on the truck three different times. The truck has been in service since early June of 1919, and up to the first of March this year not a cent had been spent on repairs, yet it seems to be in good condition.

Eugene De Prez, of 105 Aldine Street, Rochester, New York, is another who reports satisfactory service from his Armleder truck. He has operated the truck in state road construction work through some of the roughest parts of New York state. Although used under adverse conditions he recommends this truck highly.

The O. T. Roehl Company, contractors, Knoxville, Tennessee, report the use of a 2-ton Armleder truck with a hydraulic dump body. They commend the truck because it sets low down on the ground and is easily loaded by hand-shovelers. This user states that the patented spring rocker eliminates spring troubles and states that the truck has several other smaller parts not usually found on trucks which add to its excellence. This user hauls sand, rock, cement, lumber, dirt and in fact a little of nearly everything.

Hoisting Machinery

A very interesting and useful catalog on hoisting machinery has been issued recently by the Mead-Morrison Manufacturing Company, of East Boston, Massachusetts. This catalog, No. 21, contains 160 pages and is very attractively printed and illustrated. The catalog is devoted principally to steam and gasoline hoists, belt hoists and electric hoists, suspension cableways, clam-shell and orange-peel grab buckets. The catalog is especially interesting to quarrymen, contractors and bridge builders on railroad, dock, sewer and subway construction; it shows equipment used in dredging, logging, hauling, erecting and driving.

The products of this company comprise two distinct lines of machinery; namely, hoisting machinery, and coal, ash and ore-handling machinery. The catalog mentioned is intended to cover principally the hoisting machinery line and is divided into four sections; namely, steam hoisting and swingers, electric hoisters and swingers, gasoline and belt hoists, and clam-shell and orange-peel grab buckets. This line of machinery has been brought to a high degree of perfection by improvements made from time to time. No expense has been spared in construction to reduce the liability of breakdowns.

The steam and electric hoists follow the same general design, the chief difference being that in the steam hoist the frame is extended to support the boiler and cylinders, while in the electric hoist the extension is such that the motor, controller and resistance are similarly mounted. The catalog illustrates and describes the various details of construction of the Mead-Morrison hoists. All these hoists are thoroughly inspected and properly adjusted before leaving the works and are ready for actual service when shipped. The manufacturers endeavor to have finished steam and belt hoists of all regular sizes in stock for immediate shipment, and electric hoists of a similar size ready for the mounting and wiring of the electrical equipment. They can quickly fill orders for hoists not on hand as the parts are kept in stock and are easily assembled.

Reducing Idle Time

The idle truck not only earns no profits, but represents a steady loss. To obtain a maximum return on the investment, a maximum of work must be produced by the truck.

Overhead expense, including depreciation, interest on investment, insurance, garage charges, etc., is constant whether the truck be on the road or in the repair shop. But when the truck is working, this overhead expense is swelled by driver's wages, gasoline, oil and tire cost and similar items. It is obvious that the greater the amount of actual work accomplished, the most this cost is dissipated.

Owners increasingly are giving their attention to methods or devices that reduce a truck's idle time. Primarily, the truck must be maintained in good mechanical condition. This condition attained, it becomes a problem of increasing the number and frequency of paying loads.

Systematic and expert inspection should anticipate nearly every mechanical trouble, barring those caused by accidents. Thorough and frequent lubrication is the most effective preventive against the many seemingly insignificant troubles which cause costly delays.

Many factors enter into the problem of increasing the number and frequency of paying loads. Proper routing and dispatching, efficient loading and unloading methods, and the use of the logical size of truck for the work to be accomplished are among them. Each of these elements is treated specifically in matter being issued by the Pierce-Arrow Motor Car Co. The article on Lubrication follows:

Lubrication

Lubrication is undoubtedly the most important factor in truck maintenance.

Intelligent lubrication is systematic lubrication. Each day the truck or trucks should have an allotted period for greasing and oiling. The driver, in the case of one or a few trucks, should be required to go carefully over his truck and turn down all the grease cups.

The life of a truck is increased by proper lubrication. The wearing parts are thoroughly protected when coated with a film of oil or grease and wearing is considerably lessened, not overlooking the fact, too, that friction is decreased within the truck itself, leaving more power for the overcoming of road resistances.

The engine oil should be changed at regular intervals and occasionally kerosene run through the engine to clean it out thoroughly, removing any foreign particles or old oil sticking to the metal. This is insurance against scored cylinders or burnt-out bearings.

Often the thought is that the time spent in lubrication is lost time, but the advantage in overcoming large repair bills more than outweighs the so-called wasted time.

A half-hour each day spent in systematic lubrication prevents repairs requiring days and sometimes weeks.

GRAMM-BERNSTEIN TRUCKS

GRAMM PIONEER BERNSTEIN

To many a business man and truck-owner, the Gramm-Bernstein records of longer life at lower cost, doubtless *do* seem remarkable.

Yet they are not remarkable at all, when you stop to consider the truck itself.

The fact that Gramm-Bernstein *is* a *better* truck, that lasts *longer* and does *better* work at *lower* cost, is simply clear, cold logic.

For that is exactly what it is built to do.

It is built conscientiously. It is built carefully.

It is built of the best materials we can find, with the best engineering we can bring to bear.

Not best because we think so or say so. But because 20 years of truck-building have proved them so.

Is it strange, then, that the Gramm-Bernstein should excel in long life and downright economy?

Or that our owners, ninety-nine times out of a hundred, add Gramm-Bernstein when they need another truck?

Our dealer is prepared to lay before you Gramm-Bernstein figures which will help you to choose a truck to your own good advantage.

It will pay you to learn about Gramm-Bernstein standard equipment, which is worth $500 to $550, and is included in the cost price of our worm-drive models.

The T. C. Long Stone Company, at its quarries near Lima, Ohio, operates six five-ton Gramm-Bernstein Trucks; during busy seasons the trucks are kept going 24 hours a day. The company states that they are so dependable it can almost be said that they never need repairs. Two Gramm-Bernstein five-ton trucks were added to the Long fleet last fall.

Ship by Truck

All Gramm-Bernstein Transmissions are trouble-proof and are provided with a pad for attaching Gramm's Basic Patent Power Take-off. Dealers and truck owners should assure themselves that any trucks purchased with power take-off do not infringe B. A. Gramm's Basic Patent No. 1194994.

The Gramm-Bernstein Motor Truck Co., Lima, Ohio

Pioneers since 1901—Builders of the First Liberty (U.S.A.) Truck

Using Trucks for Snow Removal

Severe weather in various sections of the country throughout the winter as far south as Texas, as far west as the Pacific coast and throughout New England choked the highways with snow.

To put these roads of communication in condition rapidly for the traffic so essential to business motor trucks were called upon because speed was essential. The increasing use of the truck for this purpose has come about through the pressing need for clear thoroughfares.

In Salt Lake City this last winter Federal trucks were used to keep the roads clear of snow, while in almost every large city of the country similar fleets were in use throughout the winter.

Even inter-city transportation has assumed such importance that many of these companies ran their own plows to keep open the roads used between cities.

FEDERAL TRUCK WITH TRAILER AS OPERATED BY STREET DEPARTMENT OF SALT LAKE CITY, IN SNOW REMOVAL.

The importance of this rapidly developing new line of work for the motor truck may be gleaned from the fact that a recent snowstorm in New York City required the services of 14,000 men working for a week to clear the snow away.

Motorizing All Municipal Departments

"That municipalities will soon be motorized in all outdoor departments is proven in almost any live, wide-awake city," says Harry Branstetter, Chicago Kissel distributor.

"First the fire department, then the hospital ambulance, the park departments, then that of the city garbage, have been so motorized that a fire or ambulance horse is a curiosity.

"And now the street cleaning department is being motorized. Even now the street cleaner or 'white wing,' as he was popularly referred to, is a rarity in our metropolitan cities. Motor-driven street sweepers cover as much territory in a day as 20 men sweeping by hand, and in addition save 40 per cent. in cost.

"Motor-driven gutter sweepers and street flushers finish off this 'municipal manicuring' ten times better, with a big saving in time and labor."

Cost Comparison of Truck and Wagon Haulage

The Dixie Bee Line Company of Mortons Gap, Ky., which operates what is generally called a wagon coal mine, necessitating a haulage of about a mile, made a net saving of $18.43 per car when they changed from wagon to truck haulage.

"We formerly loaded coal with wagons," wrote G. E. Henry, secretary of the company, "and in order to get a true basis of costs it would appear that the proper method would be to make a comparison between the wagon and truck haul. Considering that we load on an average of 50 tons per day on railroad gondolas, the wagon haul costs 60 cts. per ton or a total of $30 per car."

The truck haul figures given were as follows: Driver, $4; gasoline and oil, $3; interest on investment, $0.83; depreciation, $2.60; estimated repairs, $1; total, $11.43; as against $30 for the wagon.

These records were made with a Federal 2-ton truck over an ordinary dirt road, crowned in part with cinders and part with a mixture of cinders and dirt. The change was made while the war was on.

"The truck has been our salvation in the coal business," writes Mr. Henry in part, "for the reason that the fuel administration had ordered the railroads not to furnish cars for the wagon mines, and as a consequence the wagon mines have been compelled to close down, but owing to the fact that we had the motor truck haul and were able promptly to load a car when it is placed for us, we got our cars along with the larger mines. The truck really costs us nothing, as we are paying for it at the rate of $225 per month and the difference between the truck haul and wagon haul easily takes care of this payment with a good margin to spare."

Considerations Affecting the Choice of Trucks

There are so many possible factors to be considered in the selection of a motor truck (or motor trucks) to cope with a particular hauling problem that it behooves the prospective purchaser to obtain expert advice from the manufacturer, or his representatives, before buying, according to The Garford Motor Truck Company.

This is especially true where the buyer has had no previous experience with motor truck equipment.

Hauling problems naturally vary in different lines of business, in different localities, and with other governing conditions. There are numerous items which are to be given consideration in selecting the right truck for the right job. Among the more important are the following:

First. Kind and quantities of goods to be hauled.

Second. The distribution area.

Third. The condition of highways, the grades and climate.

Fourth. Frequency of necessary stops, particularly in delivery.

Fifth. Loading and unloading facilities.

Sixth. The capability of drivers.

Seventh. Housing of equipment.

Eighth. Ability of manufacturer to give service.

Ninth. Speed which can be maintained in accordance with state and city laws.

Tenth. Advisability of pneumatic tire equipment.

Eleventh. The institution back of the motor truck.

In many instances it would not be necessary to consider all these factors; in other instances it might be essential to consider others, all in accordance with the circumstances.

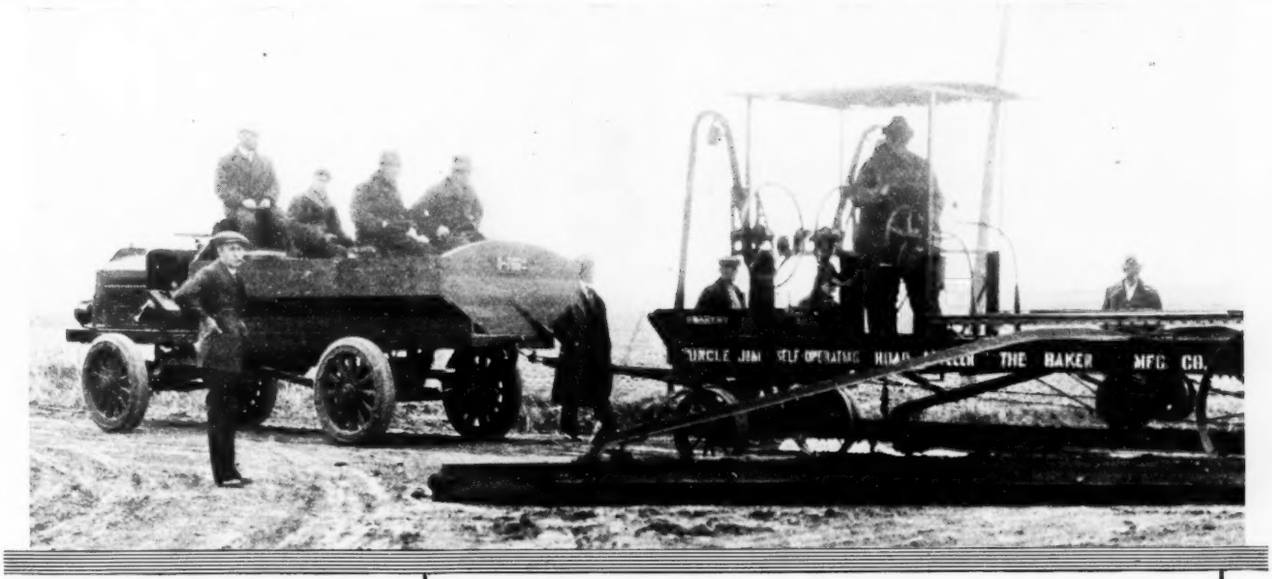
Union Depots for Motor Truck Freight to Facilitate Shipping

Further evidence of the proven practicability of the motor truck express is disclosed in the establishment in Toledo, Ohio, of a union depot solely for motor truck freight.

An organization of independent trucking concerns, founded a year ago for the development of inter-city mo-

DUPLEX TRUCKS

BUILT FOR BUSINESS



Why the Duplex Limited is Winning Enthusiastic Approval all over America

WITHOUT question the remarkable success of the Duplex Limited is due to the confidence that truck users all over America have in the Duplex Truck Company as builders of trucks that a business man can consider an investment in practical trucking efficiency.

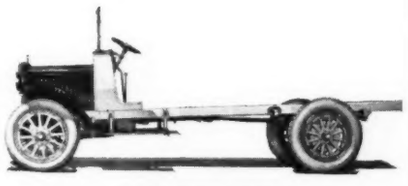
What does the steady, persistent growth of the Duplex Truck Company signify as regards this Duplex Limited?

For one thing it means that the Limited is designed and built by a company that is *known to be successful* —a company that is famous for building good trucks.

Medium Capacity—Two Wheel Drive—Complete Electrical Equipment — Pneumatic Tired — *High Speed*—it is a wonderful truck for general business hauling.

4 Cylinder, enclosed type motor—water cooled—cast enbloc—Bore 4". Stroke 5¼". 3 Point Suspension. Pneumatic Cord tires. 145" Wheel Base. Electric Lighting and Starting, Equipped with Windshield, Ammeter; Boyce Motometer; Speedometer; Electric Horn; Tools; Jacks; Rim Wrench; Front Fenders; Alemite High Pressure Lubricating System; Driver's Seat without extra charge.

Talk to the Duplex dealer in your vicinity. Find out for yourself why the Duplex Limited already is known as a very safe investment for a business man.



The Duplex 4-Wheel Drive Truck Actually Does Reduce Road Making Costs

IN these days of climbing endless costs, if any man can show you a product that will do double duty, and do it as well, or better, than a similar product will accomplish a single job, you don't need any further argument for superiority.

Apply this thought—or rather this fact—to the Duplex 4-Wheel Drive, and you will readily understand its acknowledged superiority in road-building.

Down in Franklin County, Missouri, last season, instead of scarifying and grading, they hooked up a Duplex to a scarifier and behind it a six-horse grader. The scarifier tore up the old road bed, the grader distributed the load, and in one operation the road was ready for rolling.

As a consequence, L. J. Kreul, Secretary of the road Commission for Franklin County, writes: "We hold high place in this county for building more and better roads at lowest cost."

Economy! Listen to this from Judge E. O. Kirkpatrick, Chairman of the Polk County, Oregon, Road Commission: "The County purchased one (Duplex) last Spring and has not spent one cent for repairs other than replacing tires. The truck made as high as eighty miles a day hauling three yards of gravel to the load. This Duplex has run 7000 miles and has never been out of commission. Polk County will buy another Duplex this Spring."

In the face of facts like the above, it is not a matter of surprise that the Duplex 4-Wheel Drive is steadily replacing all other forms of transportation, whenever new roads are being built or old ones repaired.

Every road commissioner should get the story of Duplex successes in building roads better and quicker and more economically.

Talk to the nearest Duplex dealer. He not only has the facts, but he is ready to show you by actual demonstration against any make of truck you propose.

DUPLEX FOR BUSINESS

Duplex Truck Company
Lansing · Michigan

One of the Oldest and Most Successful Truck Companies in America

tor transportation, is responsible for this innovation. Business has grown so rapidly within the course of the year that the building of a station in the heart of the city was made necessary to facilitate shipping.

This building is a modern structure of two floors and basement. The equipment will include electric elevators and other machinery which will aid in the speedy handling of freight.

According to E. A. Williams, Jr., president of The Garford Motor Truck Company, who some time ago urged the systematic organization of motor truck interests, such depots soon will be established in all trade centers.

"The rapid development of the motor truck express in various communities will result shortly in a network of routes extending over the country," says Mr. Williams.

"With the amalgamation of trucking interests and the improvement of the highways this system will become a great factor in the nation's transportation.

"Without a unity of purpose there is a certain waste in transportation—a loss of tonnage hauled. Naturally this results in increased costs. The creation of highway transportation commissions in various states and the organization of transportation bureaus in cities has resulted in the elimination of much of this capacity waste.

"These latter associations, comprising the leading motor haulage concerns in the community, are centralizing trucking activities.

"The Toledo association, for instance, maintains for the mutual benefit of truck-owning members and those whom they serve, a central office and a secretary-manager. In this office an accurate check of trucks is kept on a large blackboard. The moment a member has a truck not in use he notifies the secretary and the truck is immediately posted as idle.

"Another member, whose trucks are all in operation, may receive a request from a shipper. He notifies the secretary of this request and the idle truck belonging to the first member is placed in service.

"In the inter-city hauling trucks are operated so systematically that they are assured of cargoes both ways. Rate schedules are based on the cost-plus plan and the association provides for members a course of instruction which teaches the proper way to determine expense of operation.

"All cargoes are insured by the association from the time they are placed aboard the truck at the shipper's place of business until they are delivered at their destination.

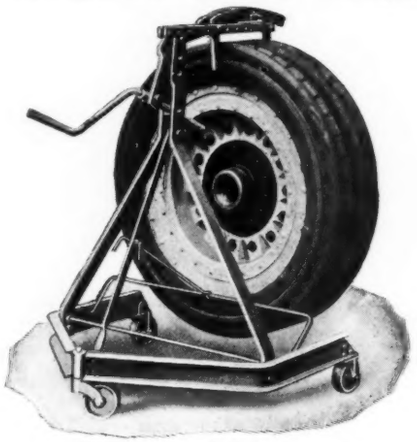
"Detroit, Cleveland, Akron, Pittsburgh and other cities in the Central West recently have established similar bureaus, and all are being interwoven into one vast system. The various associations are now serving territory within a 100-mile radius of their respective cities.

"With the organization of these associations in several more of the large centers as now contemplated, the motor truck express system in the Central States will be practically complete. There seems little doubt that it will then spread rapidly to other sections and eventually throughout the country."

Device for Removing and Replacing Heavy Truck Wheels

The new Atlas Wheel Crane, distributed by The Thomson Auto Specialties Company, Columbus, Ohio, fills a long-felt want in garages and service stations, where it is necessary to handle the heavy wheels of motor trucks. Without some such appliance as this three or four men must frequently work for an hour or longer, with makeshift tools, to remove or mount a heavy truck wheel. The Atlas wheel crane, operated by one man, will do the job in one minute, it is claimed, exclusive of time required to jack up the truck and take off hub cap, axle nut, etc. This means a considerable saving in labor and idle truck time, in greasing wheels or giving attention to brakes and bearings.

The operation of the crane is extremely simple. Brought up to the wheel, the grab hooks reach in under the fender and grip the rim on either side of the wheel. A turn of a crank is all that is necessary to lift the wheel so that it hangs free. The crane and the suspended wheel are then rolled back from the truck. An adjustable stop



THE ATLAS WHEEL CRANE.

on the crane holds the wheel in vertical position so that when repairs or adjustments are completed, the wheel is slipped back into place in the same easy fashion and the grab hooks released.

The construction of the Atlas wheel crane is powerful. All parts except casters are of forged, machine or channel steel. They are built much stronger than necessary, for the crane is designed to lift a ton. The grip of the grab hooks is positive. The crane eliminates all danger of injury to men or of damage to bearings or brake linings, so common when this job is done by hand. The crane is adjustable to any size of wheel or tire, and can be used in any clearance between wheel and fender or body. Special grab hooks are supplied for pneumatic tires.

Federal Truck on Mountain Hauling

Ten years ago it took 28 mules three days to transport a 9-ton boiler 5,000 ft. up in the Sierras to the Madera Sugar Pine Mills, 60 miles distant from Madera, Cal., the nearest railroad point. Recently a 5-ton motor truck performed the same task in one day, despite the prophecies it would never make the steep mountain grades and pitches. The truck was a Federal.

Harvey Shuman, the operator of this unique truck system which keeps this isolated camp with its thousands of inhabitants supplied with the necessities of life and power machinery for work, declares that his statement that he could get this huge boiler for use in one of the yards at the camp was laughed at.

The roads were considered treacherous, full of dangerous winding turns, often attaining a grade of 20 per cent. Experienced truckmen who saw the boiler loaded from a

Federal Government Truck used on road work near Des Moines, Iowa

Another

FEDERAL

Federal Trucks for County or City Use

The knowledge that the truck you buy for municipality, county or township work has the ability to do its work faithfully, 360 or more days each year for a long period of years in the knowledge that will prompt you to make "Another Federal" the next truck you buy.

Federals everywhere—on state, county or city jobs—and giving the same care-free, dependable service that has made them so popular in this field.

They are built in capacity of from one to five ton capacities—a capacity and size for your every need.

"Traffic News," an interesting magazine on the subject of haulage, sent monthly on request.

FEDERAL MOTOR TRUCK COMPANY
35 FEDERAL STREET DETROIT, MICH.

This is the sign of the 10th year Federal —a sign significant of ten years' success in every field of truck transportation.

"Shorten the Miles to Market—Use Motor Trucks"

flat car to the truck, prophesied that the trip could not be made, but it actually arrived at the mills, 65 miles up in the mountains, without a mishap.

There are many of these donkey engines at the mills in addition to locomotives which are used for hauling timber from the forest to the mills. All of this machinery must be hauled over the mountain roads. The value and economy of the new method, which replaced mule transportation, is strikingly illustrated in the incident related above.

In order to save the brakes of the truck which carried this 9-ton boiler, it was necessary to chop down one of the larger trees and drag it behind the truck whenever a steep grade was reached. In one place the flume, which permits the lumber, cut up, to float down to Madera, had to be cut to allow the truck to pass with its huge load.

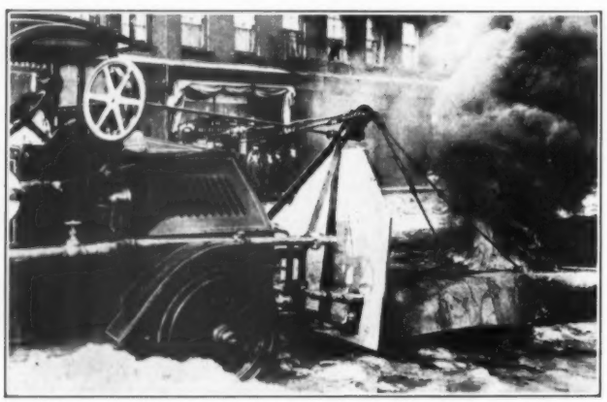
A fleet of four Federals, one of which has been operating four seasons, running an average of 20,000 miles each year, are used continuously to keep in supplies 800 men in this mountain town for approximately eight months of the year regardless of weather conditions or road conditions, bringing machinery for the mills and mail, food and clothing for the men.

Novel Invention Removes Snow and Ice by Melting

Snow and ice-clogged streets in the large Northern and Eastern cities during the past winter months brought out many new types of snow removal apparatus.

One of the most novel and successful of these innovations was the oil burning snow melter shown herewith mounted on a Mack 7½-ton truck in use in Brooklyn, N. Y. It is the invention of L. V. Stevens, a Canadian engineer, and was first used successfully by the Canadian Pacific Railroad to clear its tracks.

The truck, which carries a 1,800 gal. tank of crude oil, travels at the rate of five miles per hour, belching an incandescent flame some 10 ft. ahead, collapsing snow banks as if by sunstroke. The oil and air are both forced ahead under compression through a mixer or carburetor, in a manner similar to the practices established in the case of blast furnaces and oil burning locomotives.



OIL BURNING SNOW MELTER MOUNTED ON MACK 7½-TON TRUCK GIVING DEMONSTRATION ON A BROOKLYN, N. Y., STREET.

Two pipes extend in front and crude oil from an 1800 gal. tank on the truck is forced through the pipes while burning.

Republic Fire Truck Passes Underwriters' Test

On Jan. 13 of this year a Republic truck, Model 19, 2½-ton chassis, fitted with the Republic standard triple combination fire apparatus, successfully passed the fire truck test of the National Board of Fire Underwriters. This test is usually held yearly and is a stiff one.

The test on Jan. 13 was a special one, made at the request of the Republic Motor Truck Company. The testing was supervised by the chief engineer of the National Board and took place at the Fifty-fourth street pier on the Hudson River.

The Republic truck actually pumped water continuously for 13½ hours, and at the conclusion of the test, the official report says, "the motor and pump at the end of the test were quiet, cool, in satisfactory condition, without vibration or pulsations."

The test is divided into three main parts, although readings were taken every five minutes as to pressure, vacuum of pump and nozzle pressure.

The first test was completed in six hours and showed a new pump pressure of 120 lbs. and an average motor speed of 1,350 R. P. M.

At the end of nine hours the second test was completed, the net pump pressure being 200 pounds at 1,625 R. P. M., the pump being geared to the transmission at second speed.

The third test was completed with 12 hours of continuous running and showed a pump pressure of 250 pounds at pumping capacity of one-third full capacity at 1,250 R. P. M. The pumping was continued an hour and a half after the completion of the tests for good measure.

The next day the fire truck was given the road test of the board, which is extremely severe. A special course covering 20 miles is laid out, the pavement embracing macadam, asphalt and brick pavements in various conditions, and the truck must cover this distance in one hour.

The Republic made the trip in 50 minutes and 20 seconds and was loaded with 1,000 ft. of regulation 2½ in. hose and eight men, a regular sized crew. Further tests in hill climbing and descent were made, and in every test the Republic made a perfect score.

Burned Kissel Truck Successfully Rebuilt

Three years ago a Kissel truck was lying in a California desert, an apparent wreck.

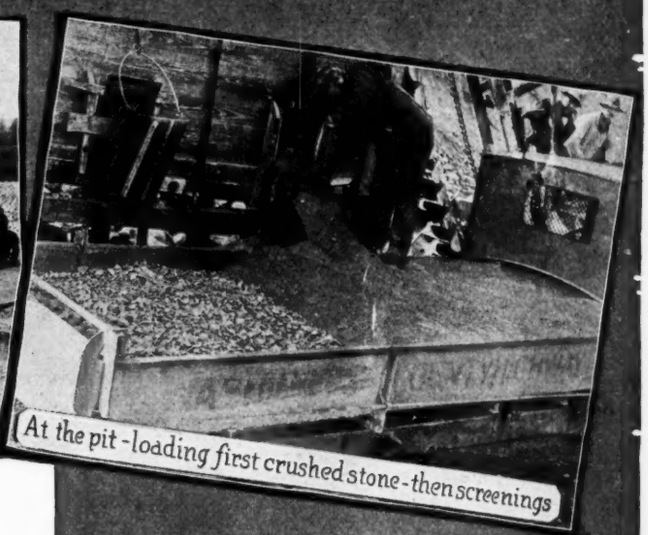
Three years ago the Magnet Lumber Company purchased the so-called wreck for $185, which was the cost for hauling it from the desert to their service station. Since then the truck has been doing an every day service, hauling loads of sometimes a total of more than six tons and covering an average of 40 miles a day. F. B. Lyon, of the Magnet Lumber Company, has the following to say regarding the truck's history and the manner in which the apparent junk pile was turned into a big paying investment:

"You don't often pick up a 4-ton Kissel truck for $185, but it is doubtful if you would have offered even that much for this one if you had seen it in the condition that it was when we bought it. The truck had been in use for a year or so on the desert, and in some way had caught fire when carrying a highly inflammable load. The truck burned literally right down to the steel of the chassis. Even the rubber of the tires was mostly consumed. For a year it lay on the desert, a rusting wreck, when it became necessary to haul it into Los Angeles in order to settle the matter of adjusting the insurance.

"We bought it for just the price paid for hauling it in

Building Roads in Wisconsin with Kissel Trucks

The necessary equipment in the gravel pit



At the pit - loading first crushed stone - then screenings

WASHINGTON County, Wisconsin, wanted good roads. The county commissioners, who had a nice appropriation for road maintenance, were determined to get as much road for their money as possible.

How they made use of available material, purchased necessary equipment; how they are building 14 miles of good roads with the aid of only one Kissel Truck—a "Heavy Duty" model—will prove interesting to all road builders, contractors and county commissioners.

Incidentally they developed special loading and dumping methods which saved time and labor—original features you could use to great advantage.

All set to distribute load

KISSEL TRUCKS

Performance Proof Folder Highway No. 3

It's free to contractors, county commissioners and others who have road construction, building or maintenance work planned.

Write the Kissel Contractors' and Good Roads Building Division for Kissel Truck Performance Proof Folders and other practical data.

Load evenly spread by the driver from his seat

Kissel Motor Car Co., Hartford, Wis.

ACME

Trucks Owned by Udelson Contracting Company

4 Money-Making Trucks

This great battery of four 5-ton Acme dump trucks, owned by the Udelson Contracting Company, Cleveland, Ohio, is earning a surprisingly high average of profit daily for this well-known contracting concern. Acme proved construction insures profitable truck service, especially in heavy duty work.

You can always bank on Acme to produce its usual high standard of performance, for proved construction insures the use of only known units, proved and tested in service and accepted by the world's leading engineers as the best.

Acme is the preference in heavy duty and construction service—because Acme is built specially for that work. With our modern truck building factories and complete wood and steel body building plants we can make immediate delivery of completed trucks ready for service.

Built in 1, 1½, 2, 3½ and 5 tons models

Investigate the high place Acme holds in engineering and construction service and solve for all time your hauling problems. Write for our book, "Pointers to Profits."

ACME MOTOR TRUCK COMPANY
190 Mitchell St., Cadillac, Mich.

The Seal of Dependable Performance — Trade Mark Reg. U. S. Patent Office

from the desert. We brought it down to our shop and went after it. The motor was hurt very little. The frame was warped and the temper spoiled, so we put in a new frame and new bearings throughout the transmission and wheels. With new tires and a new body, the truck stood us in about $1,400 by the time we put it in service.

"That was three years ago, and we wouldn't take $1,500 for the truck today. We have charged depreciation enough against the truck to wipe its cost off our books, and it is apparently as good as it was the day it went into service. It was only rated as four tons to begin with, but we haul five and six-ton loads and think nothing of it. It averages about 40 miles a day and covers seven miles per gallon of distillate."

Service Truck Makes Record for Long Distance Hauling

After traveling a total of 670 miles, Dick Arnold, driver for J. A. Kern & Son Company, Frankfort, Ind., recently arrived in Frankfort from Cleveland, Ohio, where he had gone to take household goods belonging to some Frankfort people who had moved to Cleveland. This trip set a record for long distance hauling in that community. He drove a Model 76 3½-ton Service truck, heavily loaded. He left Frankfort at 5 o'clock Tuesday morning and arrived in Cleveland at 7:30 Wednesday evening. He left Cleveland at 1:30 Thursday afternoon and arrived at Frankfort forty-eight hours later.

He said that during the entire trip he had absolutely no trouble. He averaged a little better than 13 miles an hour and used 83 gals. of gasoline and 6 gals. of oil on the entire trip.

THIS IS THE

Heltzel "Lightning" Loader Skip

It is perfectly designed and built for its special purpose—strong and rigid, properly reinforced and fortified.

Collapsible—readily moved about.

Adjustable to any condition—high car, low truck, or vice versa—easily operated. It will decisively cut operating costs and increase profits.

The Heltzel Steel Form & Iron Co.
WARREN, OHIO.

Packard Truck with tank body and special street-flushing equipment. Note how the Packard concentrates the load on the rear axle—with advantage of easier control and less wear from vibration.

Keeping the Traffic Arteries Open

IT is estimated that last February's storm cost the New York public alone over a million dollars a day—largely due to antiquated snow-hauling equipment.

One bad storm often wipes out all the apparent savings of years in buying trucks on a price basis.

The City Official who feels the responsibility of keeping the highways open is looking more and more at what a truck can *do*—rather than the price at which it can be assembled.

The following National Standard Truck Cost System facts on the performance of over 1700 Packard Trucks in 1919 have a *vital significance* for the truck user.

An average *saving in gasoline* of 10 *per cent*—due to greater efficiency in operation with the aid of the National Standard System.

The National Standard System used in connection with Packard Trucks has shown it possible to reduce cost per ton mile.

Truck owners who have used the System for a year or more, and have compared the Packard with other trucks, are *standardizing* on Packard.

The driver finds the Packard easier all around to handle.

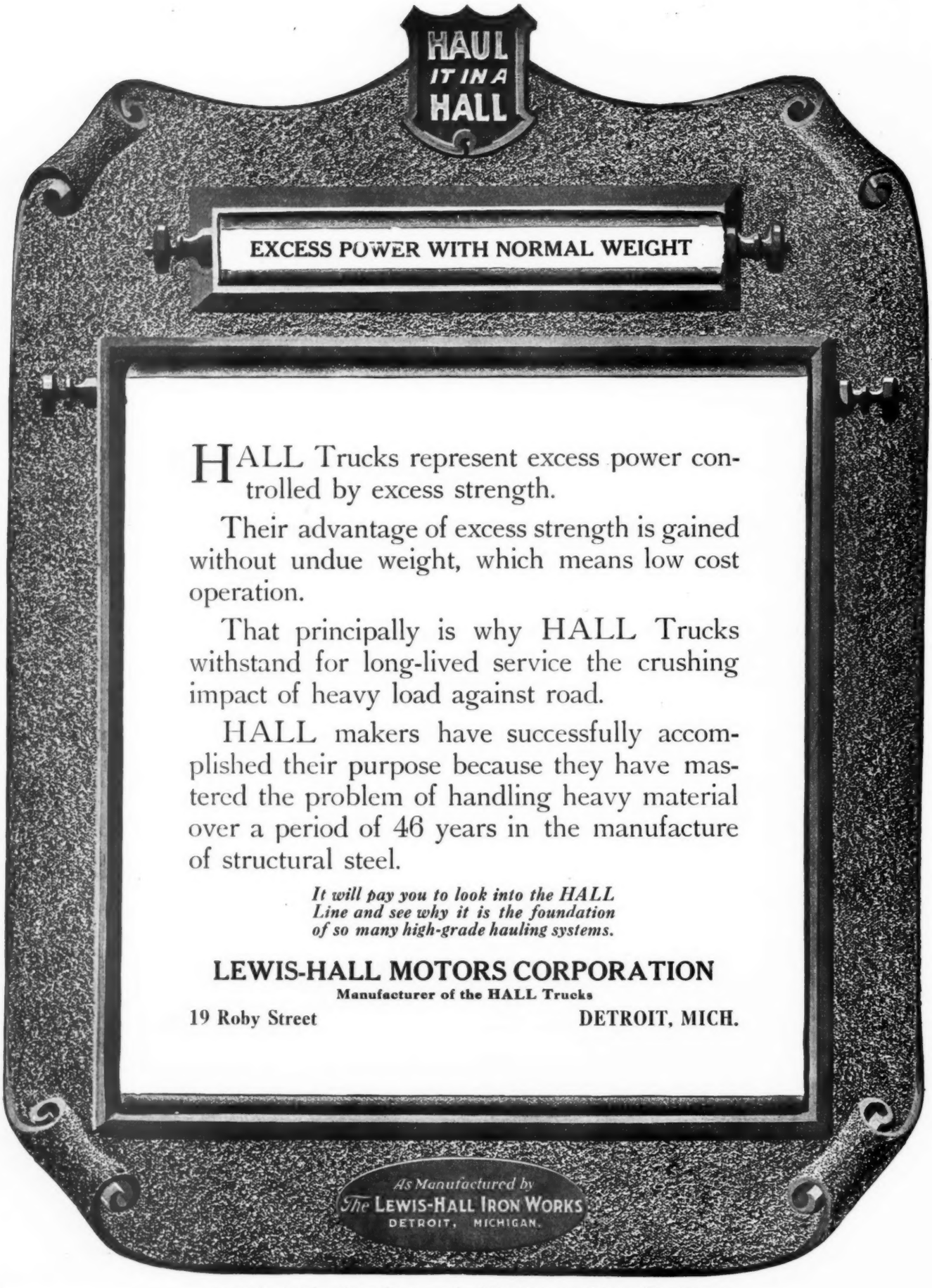
Less vibration; because of the *smooth-running* Packard engine, the construction of the worm drive, and the placing of 85 to 95 per cent of the live load on the rear axle.

Easier handling on the hills, owing to Packard high tractive force on the road; and four-speed transmission graded up by regular steps.

With the thinking City Official, these transportation economies far outweigh "features" and "talking points."

"Ask the Man Who Owns One"

PACKARD MOTOR CAR COMPANY, *Detroit*


HAUL IT IN A HALL
EXCESS POWER WITH NORMAL WEIGHT
HALL Trucks represent excess power controlled by excess strength.
Their advantage of excess strength is gained without undue weight, which means low cost operation.
That principally is why HALL Trucks withstand for long-lived service the crushing impact of heavy load against road.
HALL makers have successfully accomplished their purpose because they have mastered the problem of handling heavy material over a period of 46 years in the manufacture of structural steel.
It will pay you to look into the HALL Line and see why it is the foundation of so many high-grade hauling systems.
LEWIS-HALL MOTORS CORPORATION
Manufacturer of the HALL Trucks
19 Roby Street
DETROIT, MICH.
As Manufactured by
The LEWIS-HALL IRON WORKS
DETROIT, MICHIGAN.

EDITORIALS

WHERE CHLORINATION WOULD HAVE PREVENTED SICKNESS AND DEATH

The protection of human life is the highest form of civic enterprise in times of peace. Nothing is so discreditable to public officials as to be neglectful of the public health where measures for safeguarding it are generally well understood and widely applied. It is with the greatest regret that one learns of official carelessness or incompetence leading to the loss of life, but where such cases occur they must be cited as warnings to others with a disposition to be neglectful of official duties.

A certain city in western New York derives its public water supply from a grossly polluted river. The raw river water is admitted to the intake pipe line at a point far off shore, and pumped through the distributing mains to the consumers without filtration. Not until last summer was this water sterilized, and before sterilization was inaugurated the city experienced a severe water-borne typhoid fever outbreak. A break occurred in the intake line, at a point much nearer shore than the intake crib, where the pollution of the water was, of course, much greater than in the vicinity of the crib. As a direct result of admitting the highly polluted water to the city mains, typhoid, always prevalent in the city, became epidemic. During the epidemic there were 236 cases of typhoid, with 18 deaths.

There have been many water-borne epidemics of typhoid which could not very well have been anticipated, but in the case under discussion the epidemic was sure to come and was anticipated by the State Department of Health, which, lacking mandatory powers in the premises, labored for years with the city officials and the Chamber of Commerce, urging that the water supply be sterilized to safeguard the lives and health of the citizens.

The investigation of the epidemic plainly demonstrated the fact that had a chlorination plant been installed and in proper operation prior to this outbreak, as had been repeatedly recommended by the State Department of Health, the outbreak would not have occurred. It also developed that when a belated installation of a chlorination plant was made, there was an almost immediate checking of the outbreak and this undoubtedly prevented a much more severe outbreak from subsequent leaks in the intake line.

Thus chlorination once more demonstrated its efficiency. But the dependability of chlorination was established some years ago, and it is in the last degree unfortunate that the officials of this particular city did not avail themselves of a process of demonstrated worth which had repeatedly and urgently been brought to their attention as the very least measure they should adopt to protect the people of the city.

There is no longer any excuse for failure to sterilize all public water supplies of surface origin, and filtration is also highly desirable with all such supplies. Sanitary engineers have developed these processes, particularly chlorination, to a highly efficient point, and chlorination is easily within the reach of all communities where it is needed. Knowledge of the process is so widespread and so easily obtainable in detail, that it is now nothing short of criminal carelessness to distribute unsterilized water of surface origin for drinking purposes. Ground water supplies have also been contaminated so it is the first duty of every water works official to make sure that he is distributing a safe water. It is much better to sterilize in time than to be sorry after the epidemic has taken its toll in sickness and death.

OBLIGATIONS ARE RECIPROCAL

There has been considerable discussion of the rights and obligations of public employes since the Boston police strike of some months ago. It will be remembered that the thought of a strike by policemen was so abhorrent to the public that the Governor of Massachusetts was widely applauded in connection with the stand he took in this distressing occurrence. In fact, so universal was the commendation of the Governor that for weeks he was mentioned as a presidential possibility.

There can be no doubt that the public rebels at the suggestion of a strike of its employes, so the Chicago firemen, feeling themselves seriously underpaid, did not strike, but turned in wholesale resignations. Clerks employed in the City Hall at Chicago did actually "go out" for a couple of days.

The public is now taking its second thought with reference to these matters. It is perfectly natural and perfectly easy, seemingly, to strike a patriotic attitude and say that the public employe must not strike. It gives one a fine, inexpensive thrill to hold that policemen, firemen and others should never strike under any circumstances. That is, the thrill is inexpensive to the public, but the public employe pays for it, and right there is where the second thought on this subject comes in.

If it is held, and it is, that public employes are in honor and duty bound not to strike, then in all justice and conscience it follows that the public is in honor

and duty bound to pay adequate wages and salaries to its employes. This applies to all classes of public employes, whether city, county, state or federal, and to all grades, whether firemen, policemen or professional engineers.

Let us consider the case of the fireman, which we certainly can do without prejudice. Here is an able-bodied man, devoting his full time to the performance of an indispensable public service. With his intelligence and his physique he could earn very high wages in industry today, yet these splendid men have been paid only $1,800 a year by the great city of Chicago. They asked for only $300 increase in salary and it was denied them. Still, the suggestion that these men might strike or resign aroused a great show of indignation in many quarters. It must be remembered that the fireman's dollar buys precisely as much as the dollar of the organized, striking, skilled workman. If the latter compels the public to pay him more, then in all fairness the public employe must be voluntarily compensated for adjustments which continually decrease the purchasing power of his dollar.

Certainly we have no desire to contribute to the spirit of unrest. We have no sympathy with strong-arm tactics, but stand for the "established order," the good old plan under which individual merit was rewarded. But it is idle to expect that the guardians of the established order, the public employes, can remain loyal forever to old institutions which make no adjustments to meet a changed world. Sooner or later the individual public employe will choose between serving his family or the public, unless properly compensated, and no one has any right to expect that he will continue indefinitely to take from his family and give to the public. We doubt if public employes will do much striking, but they will drop public service for more remunerative forms of employment, unless they are raised from time to time like other wage-workers and salaried employes during these times of continuous economic readjustment. This will inevitably mean that many of the more efficient and ambitious will be lost to the public service.

THE MILITARY ENGINEER

In a recent editorial in this magazine engineers were urged to make use of the magazine formerly called "Professional Memoirs" in preserving to posterity a record of their professional activities directly connected with the recent war. Our point was that the belated war stories now being elaborated should be published where they will have the best chance of usefulness later on, while producing a minimum of irritation at the present time.

We are now in receipt of a copy of "The Military Engineer," formerly "Professional Memoirs." This is the journal of the Society of American Military Engineers. It is published bi-monthly at Washington Barracks, D. C. "Professional Memoirs" was a semi-official journal published for some years by the Corps of Engineers of the United States Army. During the war it suffered from neglect, but has now taken a new lease on life under a new name more appropriate to its mission and purpose.

As has been remarked before, the engineer plays a prominent part in the national defense. Without the aid of the engineer, military operations on the vast scale that is characteristic of these times would be impossible.

In peace times the government maintains a very small corps of a few hundred engineer officers which would be quite inadequate to meet the needs of a great war. Military duties will therefore of necessity fall upon civilian engineers on the outbreak of war, as was so recently demonstrated.

The federal government is now engaged in re-establishing the Officers' Reserve Corps, including engineers, on a basis similar to that of the pre-war period. A Society of American Military Engineers is now being established, to which all professional engineers, whether engaged in the recent war or not, are eligible to some grade of membership. The objects of the society are to promote solidarity and co-operation between engineers in civil and military life, to disseminate technical knowledge bearing upon progress in the art of war and the application of engineering science thereto, and to preserve and maintain the best standards and traditions of the profession, all in the interests of patriotism and national security. The principal instrument through which the society hopes to accomplish its aims is the journal, "The Military Engineer." The magazine is not to be operated for profit and it is not in competition with any other journal, as it occupies a field of its own. But it is not published by the government and must have the support of individuals who are interested.

All will agree that the purpose of the magazine is a most worthy one. The dues for membership in the society, which include subscription to the magazine, are very moderate. We bespeak for "The Military Engineer" the ungrudging support of all civilian engineers who have any liking for military matters. We suggest, especially, that all articles relating to engineering activities in the recent war and now released for publication be offered to this new journal, where they really belong. Almost every day we receive notice that some engineer is about to address a civilian engineering society on a topic which he should make the subject of a contribution to this new magazine. The engineering societies should now concern themselves only with matters of current interest and immediate application, and engineers should use "The Military Engineer" as a repository for matter which has no immediate interest to those in civil life, but which will have the greatest possible interest and value to engineers in military service 20 years hence.

Recent Experience in the Development of Brick Pavement Construction in the City of Chicago

By H. J. Fixmer, Paving Engineer, Board of Local Improvements, City Hall, Chicago, Ill.

The city of Chicago, during the past twelve years, has used and experimented with many types of brick pavement construction. This period coincides with the writer's intimate acquaintance with paving construction in Chicago. During this time we have witnessed a great change in the volume and character of the vehicle traffic and likewise a wonderful progress in the use of materials and machinery in pavement construction. In making comparison with the results observed on many types of streets the writer has limited consideration to streets of fairly heavy traffic, built under uniform conditions and inspection and on a similar, more or less undrained, clay sub-grade.

Prior to 1908 brick pavements were built on a foundation of crushed stone, hydraulic (natural and Portland) cement base, with a 2-in. sand cushion and fillers of sand, pitch (tar) or grout. On light traffic streets where some of these pavements remain, the grout filled pavements have kept the best surface; the others being cobbled and showing uneven settlement. The brick have borne the traffic well, very few fractured brick being seen.

Pitch Filler

In 1908 Higgins Road, from Milwaukee Ave. to Edmunds St., was paved with repressed brick on 2 ins. of sand and 8 ins. of limestone macadam base with a pitch filler. This pavement has settled badly and worn uneven, leaving the manholes above the present grade. Due to the fact that this has become a heavy traffic street, it will soon be replaced by a pavement on a 6-in. concrete base. It can be safely concluded from this, and other confirmatory experience, that under conditions obtaining in our city, a concrete base, or other rigid base, is necessary. In a city having a fixed grade to maintain, due to the location of car tracks and sewer manholes along the center line, and the necessity of cutting through the pavement to repair underground utilities, a rigid, self-supporting and easily repaired base is imperative.

Asphalt Filler

In 1913 N. Crawford Ave., from Fullerton Ave. to Milwaukee Ave., was paved with repressed brick on 2 ins. of sand and 6 ins. of 1-3-6 concrete, with an asphalt filler. This pavement is 42 ft. wide with a double track car line along the center. This street was the first, or one of the first, to have an asphalt filler and a vertical concrete curb, 7x9x24 ins. in section. This street, now seven years old, presents a good appearance, is generally even and smooth and still has the joints well filled, with a matting of the asphalt filler over the wearing surface in many places, as shown in the illustration. The concrete curb is in good line and to an even grade. N. Crawford Ave., south of Fullerton Ave., was paved the same year. The curb was sandstone and the filler was pitch (tar).

VIEW OF BRICK PAVEMENT, WITH ASPHALT FILLER, ON N. CRAWFORD AVE., CHICAGO, AFTER SEVEN YEARS OF SERVICE.

This Pavement is Even and Smooth and its Joints are Still Entirely Filled with the Asphalt. Note the Matting of the Asphalt over the Wearing Surface in Many Places, making the Pavement Practically Noiseless. This is a Moderately Heavy Traffic Street with Double Track Car Line. The Board of Local Improvements of the City of Chicago has Adopted Asphalt Filler as the Standard Filler for Brick Pavements on Streets and Alleys.

Cement Grout Filler

In 1917 Belmont Ave., from N. Crawford Ave. to N. Cicero Ave., was paved using wire-cut brick on a 1-in. mortar (1-4 mix) cushion, 6 ins. Portland cement concrete base and a standard (1-1 mix) cement grout filler. This pavement is very smooth, even and rigid. The mortar cushion was spread dry and the brick laid as customary. After rolling and culling, the bricks were well wetted before applying the grout filler. This was mixed by hand in approved grout boxes and applied in two periods. The first application was free flowing and served to set up the cushion and partially fill the joints, the excess water being absorbed by the bricks and cushion. The next application was of thick, creamy consistency and filled the joints and was lightly squeegeed over the surface. This pavement is practically a double monolith with a line of cleavage between the base and cushion. It is difficult to repair and construct, but appears to have kept a good, even, smooth surface. To care for the excess wear occasioned by the presence of car tracks, and due to the vibration and movement of the cars, and wear and shock caused by heavy vehicles turning off and onto the car tracks, it has been the writer's practice to lay four or five rows of granite blocks parallel with the rail. These are laid on a mortar cushion and filled with grout or with a mastic filler of bitumen and sand. In this way the brick pavement between the car tracks and curb is subjected to uniform traffic and naturally only uniform wear results.

In 1917 Irving Park Boulevard was paved from the Chicago River to Austin Ave. The work was done under two contracts, but the specifications were the same. The brick was wire-cut, laid on a 2-in. sand cushion on 6 ins. of Portland cement concrete. The filler was cement grout laid as previously described, except that a continuous grout mixer was used on one job and carts with revolving paddles on the other job. The mixing was well done and the filler carefully applied. Difficulty was had from the first with the 2-in. sand cushion. It was rolled and dampened but it was impossible to keep the sand from coming up into the joints. Frequently large areas were relaid, but the cushion would persist in coming up. The grout filler was applied in two applications. It was difficult to keep traffic off the street, which together with the constant street car traffic, no doubt, affected the setting of the filler. The following year defects appeared. These were generally areas having the top of the brick surface shattered. To the lay mind it appeared that defective brick had been used. When the brick were removed it was found that the cushion had come up and permitted only about ½ to 2 ins. of filler to penetrate the joints. This, of course, concentrated the pressure, due to expansion, along the top edge, with the result that the bricks sheared off. A pavement, structurally, can be likened to a long, thin column. The earth braces it on one side and gravity braces it on the other. As a column it resists the force of temperature. Now if any part is weak the column becomes eccentrically loaded and the stresses concentrated there tend to fracture the structure at that point. Obviously what happens when the joints are not uniformly filled with uniform resisting material, is either a fracture of the structure or a rise or blow-out in the top surface. It should be understood that while this pavement was laid in 1917, preliminary plans were made in 1914. At that time the writer was of the opinion that a mortar cushion should be used the same as he proposed and afterwards used on the Belmont Ave. job, previously described.

The advice of the brick publicity bureau, which promoted this work, was still tempered with love for the old sand cushion and apparently they really believed that a sand cushion under a rigidly bonded brick surface was necessary to give the surface "elasticity." It must be said, however, that they were faithfully reflecting the views entertained by many paving engineers of that period.

In keeping with the prevailing practice a sand cushion was used, with the result that this pavement will not develop the service the public has a right to expect. It can be definitely stated that a grout filler requires a mortar or grout cushion. If a grout filled brick requires any artificial foundation or base, that base should be a rigid base. The existence of many manholes in the typical city street introduces weak places which seriously affect a monolith surface laid without expansion joints.

Our experience with pitch filler was uniformly unsuccessful. In our climate with its wide range of temperature, it seemed impossible to produce a tar filler that will "stay put." It is either too soft in the summer and runs, or too hard in the winter, when it cracks and crumbles and disappears as dirt. At any rate it does not protect the upper corners of the brick and they soon wear rounded like cobble-stones.

Brick Construction is Durable

Despite the abuse of wrong cushions or fillers the individual brick has "stood up" these many years. Our testing requirements have on the whole secured a good quality of brick. The main thing to consider about brick is its uniformity. The smaller the range, regardless of whether the brick are soft, hard or medium, the better the wearing surface. An exceptionally hard or soft brick will produce unevenness and be a danger to the life of surrounding bricks. In general the quality of brick turned out is excellent and dependable. Likewise the concrete base is satisfactory. This leaves the cushion and filler as the remaining sources of weakness. With a grout filler we have learned a mortar cushion must be used. With an asphalt filler a mortar, sand or other fine inert material may be used for a cushion.

Where a grout filler is used the brick should present open, uniform joints. This is secured by using wire-cut lug or repressed lug blocks. Where an asphalt filler is used the closer the joint the better, provided the filler is applied sufficiently hot to flow and fill the joints. A repressed block is as satisfactory as a straight wire cut block, although it requires more filler.

Asphalt Filler Adopted as Chicago Standard for Brick Pavements

The function of a cushion is to give the individual block an even bearing on the uneven or "unsmooth" base. After securing this bearing the cushion should be kept undisturbed by a joint filler that will prevent motion up through the joints. Because of its adhesiveness asphalt is practically as good in this particular as grout. It has the further advantage of being able to "take up" any inequality or shifting of the cushion, by moving, under the influence of heat and gravity, up and down in the joints,

combining readily with the cushion to maintain a solid mass around the brick.

The function of the filler is to fill the joints flush with the pavement surface and maintain this condition. As stated before, it should be strong enough to prevent the cushion from working up and out. An asphalt filler should be applied quite hot and should be rapidly spread and worked into the joints by use of the squeegee. After this a light dressing of fine sand is spread to form a mastic and add stability. In practice one application is usually sufficient. The asphalt not only fills the joints but fills all light depressions or imperfections in the brick surface and because of the fact that there exists a reserve supply on the surface the joints are automatically kept filled flush with the pavement surface, as the illustration shows. The filler should keep water and other material out of the joints. Asphalt is both waterproof and water-repellant. Thus an asphalt filler is sanitary and clean.

An asphalt filler is easy to renew or repair. Its use permits repairs to the pavement surface with the minimum of loss of material and time. The street can be thrown open to traffic as soon as the joints are filled. This filler permits good foothold and traction on grades as high as 12 per cent. It is easily applied, a uniform product, and requires no expense to protect or cure. It forms an elastic cushion around each brick; minimizing the effect of impact; localizing the effect of shock, cracking or breakage, and eliminates the danger of cumulative expansion or contraction. It fills all slight surface unevenness and remains in place at the joint to keep the joint constantly filled to surface. Experience has proved all these things.

As a result of this favorable experience the Board of Local Improvements of the City of Chicago has adopted asphalt filler as the standard filler for brick pavements and alleys. In streets the brick are laid with the 4-in. depth vertical; while in alleys they are laid flat with the 3-in. depth vertical. In alleys with the wire-cut surface exposed the asphalt filler builds an excellent mat and thoroughly waterproofs the brick as well as the joints; a very desirable feature when one considers that an alley acts as a channel to carry water down the center. In view of our experience with asphalt in holding its position in the joint, we are now specifying a 1-in. cushion of sand, fine screenings or slag in place of the old 2-in. sand cushion or the more recent 1-in. mortar cushion. There is no objection to the cushion working up a little into the joints under the action of the roller since the asphalt combines with it readily and makes a durable mastic which effectively seals the joint from movement below.

Conclusion

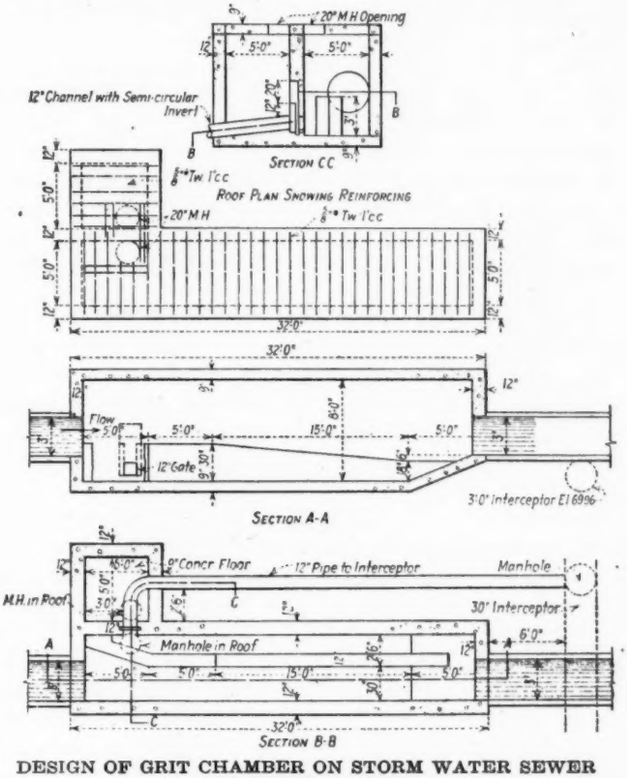
In conclusion, the writer believes the asphalt filler, with a 1-in. cushion on a concrete base, will give both satisfactory and permanent results. It is believed that where an asphalt filler is used, and where the pavement is properly maintained, no one can at this time predict the limit of life of well laid brick pavement. Practically all the maintenance required is cleaning the surface and applying a light squeegee coat of asphalt filler once in three, five or ten years, depending on conditions as revealed by the pavement in question. Recent experiments studying the effect of impact on road surfaces would seem to indicate that the presence of an elastic filler in the joints and on the surface to eliminate surface unevenness, is very desirable and can but add to the effective life and stability of the pavement.

GRIT CHAMBERS ON COMBINED SEWERS AT COLUMBUS, OHIO

By W. J. Weaver, Engineer in Charge of Sewer Construction, Columbus, Ohio

The problem of keeping grit out of intercepting sewers has always been a difficult one for the engineer to overcome. You will find, where intercepting sewers are used, that they are usually laid on very flat grades, and deposits of grit are bound to occur.

In Columbus, Ohio, the intercepting sewer is about



DESIGN OF GRIT CHAMBER ON STORM WATER SEWER IN COLUMBUS, OHIO.

8 miles in length, varying in size from 72 ins. down to 24 ins. in diameter, and the grade varies from .03 per cent. on the 72-in. to 0.15 per cent. on the 24-in.

Every year thousands of dollars are spent in removing deposits from this intercepting sewer, and while this work is being done all the sanitary sewage, above the point where the cleaning is being done, must be allowed to flow into the river. As this cannot be done while the river is low, the time is limited when such work can be carried on, and during the best part of the year the work must be stopped.

We have in Columbus 26 interceptor connections, all of which lead directly from the bottom of the combined sewer. These connections allow all the grit to be carried directly into the intercepting sewer, and the connections are being constantly clogged up by sticks, rags, tin cans, etc., and in order to keep them working properly they should be gone over every day in the summer and at least once a week in the winter.

In order to catch this grit before it enters the intercepting sewer, there was constructed in 1914 a grit chamber on the combined sewer, with a connection on the side leading to the intercepting sewer. After some studies on this grit chamber, and having made several changes in it, I finally made a design which I thought would do the work.

The first of the new design was constructed in 1916 and three others since that time. Two of them have not been put in use up to the present writing.

The accompanying plan shows the details of construction. These grit chambers vary in length and width according to the size of the sewer on which they are constructed and also on the amount of dry flow which they will carry. The stop boards leading from the chamber can be regulated for any quantity of dry flow, making the opening larger or smaller, as the dry flow increases or decreases.

The design was made to facilitate the cleaning. During rainstorms, when the flow is larger, a considerable amount of the grit will be washed out of the chamber directly into the river. Nearly all the grit will be deposited to the right of the dividing wall, or in the wide chamber, with a small amount of deposit in the narrow chamber. Most of the grit is deposited after a heavy rain and should therefore be cleaned out immediately after such a rainfall.

Cleaning is done by one or two men equipped with rubber boots and long-handled shovels. They enter the manhole over the grit chamber, and, standing on the dividing wall, throw the grit forward into the sewer outletting direct into the river. This, of course, will make a large dam, but the next rain will carry this grit directly to the river.

The frequency of cleaning will vary according to rainstorms. During the latter part of 1919 we kept a record of the approximate amount of grit removed in this way. One was as follows:

Aug. 22, 7 cu. yds.; Sept. 17, 5 cu. yds.; Oct 6, 6 cu. yds.; Nov. 10, 6 cu. yds.; Dec. 1, 9 cu. yds.; Dec. 9, 6 cu. yds., and Dec. 29, 10 cu. yds.—or 55 cu. yds. in the last six months of 1919, making an average of 7 cu. yds. per cleaning, at an approximate cost of $1.00 per cu. yd.

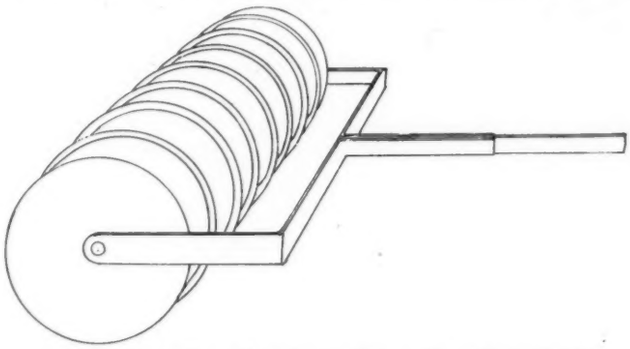
The grit chamber has proved very satisfactory in this city, and we contemplate the installation of one of these chambers on each of the old sewers having interceptor connections.

NEW DEVELOPMENTS IN CONSTRUCTION OF BITUMINOUS CONCRETE PAVEMENTS

By Theodor S. Oxholm, Chief Engineer, Borough of Richmond, Staten Island, New York

Last spring the author, at the invitation of Mr. A. Swan, Jr., C. E., City Engineer of Trenton, N. J., made an inspection of sheet asphalt pavements in that city which were laid directly on the concrete foundation without a binder course. Mr. Swan explained that by the use of a special corrugated tamper designed by himself he had corrugated the concrete base so deeply and uniformly at right angles to the traffic that there had been no creeping of the asphalt wearing surface under heavy use for two or more years, and a considerable saving in cost had resulted by leaving out the binder course.

In the Borough of Richmond the author has been using for some years concrete for pavement base composed of trap rock screenings instead of broken stone and sand, mixed six of screenings with one of cement. It was determined in a certain contract to use Mr. Swan's tamper. After about 300 ft. had been tamped, the assistant engineer, inspector and foreman on the work devised a roller made of a 2½-ft. section of telegraph pole, with bands of 1-in. round iron fastened around the roller and spaced 4 ins. on centers; a long pole attached, so that the roller could move easily, completed the outfit. The water was squeezed out of the concrete by a light roller such as is used for concrete pavement, and then as the concrete was beginning to set the corrugated roller above described was rolled across the base once for each section.



CORRUGATED ROLLER USED ON SCREENINGS CONCRETE BASE OF BITUMINOUS PAVEMENT IN BOROUGH OF RICHMOND, CITY OF NEW YORK.

The result was most gratifying, as a perfect series of depressions appeared, 1 in. deep and 4 ins. apart, uniform in character and extending the whole width of the base. It will readily be seen that this "washboard" surface will receive the asphalt or bituminous concrete and lock it so firmly to the base that creeping from lack of proper contact is prevented. It is thought that much of the creeping and rippling of the surface of bituminous concrete road surfaces is due to lack of proper contact with the base.

Proper Methods of Construction

Very often an old macadam road 5 or 6 ins. in depth makes a suitable base for a bituminous surface, provided drainage conditions are or can be made good. Care must be taken, however, in preparing the old surface, to make it as rough as possible, so as to prevent creeping of the new surface. The bond of the old pavement must not be broken, for if it is, its value is largely destroyed. Mostly all old macadam roads are now surfaced with road oil, which presents a smooth surface in patches. The best method of removing this oil surface appears to be the old-fashioned one of picking by hand lightly so as not to disturb the bond of the heavier stone. Some roads of this type which have been built by the author are quite inexpensive and are giving good service. They are edged with old stone paving blocks set in sand before the bituminous surface is applied.

The subject of drainage is an important one to the road builder. It is generally overdone, resulting in useless cost, or underdone, resulting in great damage to the pavement. It is not difficult for the engineer to tell with

approximate accuracy where drainage probably will be necessary, and make his preliminary estimates accordingly. Springs and wet places may be noted, and where changes of grades make additional cuts he should be prepared to underdrain when the work is under way and trouble is developed. The old-style stone drains, while efficient for a time, usually fill up in a few years and damage is sure to follow. The author uses 6-in. vitrified pipe with open covered joints in all French drains, which, with suitable outlets, will give good service for many years.

One of the most important pieces of road work in the Borough of Richmond which has been completed during the last few years is the paving of the Amboy road, 9 miles in length, running through the center of Staten Island and forming part of the main traveled route between New York and Philadelphia, Baltimore and Washington, and also New Jersey Coast resorts. Three years ago work was commenced on a contract for improving this road with bituminous concrete wearing surface 2 ins. thick, on a 6-in. concrete base. The specifications called for the use of Bermudez asphalt, as the traffic was very heavy. The pavement was laid 20 ft. wide and concrete edging 6 ins. in width was built up monolithic with the base. Four-foot earth wings were graded down to a uniform ditch along the sides, except where passing through built-up sections where curbs and gutters already existed. The total cost of the work was $330,000, at pre-war prices, and after two years of service the appearance of this pavement is excellent, and practically no repairs have been made. On the first section of about 3 miles it was noticed during the suspension of work for the winter that some transverse cracks had appeared; it was therefore decided to cut ¼-in. joints across the pavement as it was being laid, 300 ft. apart, and fill with asphaltic cement. On the balance of the work this was done, and no more cracks have occurred.

As the bituminous material for the wearing surface is brought onto the street it is dumped onto the base and shoveled into place for the rakers. The shovelers tread down the hot mixture so that it becomes compressed before the roller reaches it. This causes an unequal density in the completed work and tends to make the pavement uneven. One method of avoiding this is to have the entire amount of each load of hot mix shoveled and spread in adjoining locations. This causes the breaking up of the portion treaded down and the rakers soon reduce the heavier portions to a uniform service ready for rolling. Proper protection to the edges of bituminous pavements should always be provided, but often are not. If old paving blocks are not available, either concrete edging or a steel angle iron of proper design, and anchored into the concrete base, will protect the pavement from undue wear. The failure to provide this protection soon results in an 18-ft. road becoming reduced to 16 ft. in width, and the narrower it gets the more rapidly the pavement deteriorates.

Bad Practices Which Should Be Eliminated

The placing of a bituminous concrete wearing surface on top of an old penetration macadam road as a base is sure to result in serious damage to the pavement. Wherever an excess of road asphalt exists in the original pavement it will soften the new wearing surface over it and disintegrate it within a year.

While a liberal use of the oil burner in preparing the foundation will improve this condition considerably, yet in the author's opinion this form of old pavement provides a very poor base for a hot mix wearing surface.

Where an old waterbound macadam pavement has been covered with 3 or 4 ins. of penetration macadam, and it is desired to place a new wearing surface of bituminous concrete, the author has had good results from removing the penetration pavement entirely, and forming a new crown and repairs to the old macadam, with new ¾-in. stone and screenings.

One of the most important defects in bituminous pavements, and one which is undoubtedly caused by the great loads being carried by enormous trucks, is a pushing forward of the top of the wearing surface, creating waves and ripples that sometimes are so marked that the bituminous material has to be removed and replaced. In the opinion of the author this is caused by requiring a too high penetration test in the asphaltic cement. This has usually been placed at from 50 to 70 in cities near New York, but latterly the Borough of Manhattan has gone to the other extreme and laid pavements at penetration of 30. While the author believes that cracks in bituminous surfaces are preferable to ripples, and can be more economically repaired, yet a medium hardness should be called for. He suggests 45 to 50, and has been laying considerable pavement at 48 during the past summer.

Bituminous pavements adjoining the rails of street car tracks should be protected from disintegration caused by vibration of the rails. In many cities this has been neglected.

It is impossible properly to compact the bituminous material under the head and flange of the rails. The vibration during the passage of cars destroys the bond of the bituminous material, allowing surface water to enter the space thus formed, resulting in the final disintegration of the pavement. This defect may be obviated by the use of stretcher courses of stone blocks along both sides of the rails. The width of the stretcher area should be sufficient to permit the ordinary rail repairs to be made without cutting into the bituminous pavement.

Another method of construction is to pave up to a steel angle iron laid parallel to and adjoining the rails, the pavement then being practically independent of the railroad tracks.

The proper way for an engineer to find out defects in his own practice is to visit periodically other localities. He will generally find some conditions better cared for than at home, and sometimes may find that he has solved a certain problem better than his brother engineer.

The foregoing paper by Mr. Oxholm was presented at the recent annual meeting of the American Road Builders' Association.

MANY PROSPEROUS ILLINOIS VILLAGES STILL UNSEWERED

While Illinois is probably as progressive as any state, it still has hundreds of prosperous but unsewered villages. Poverty is almost unknown in these agricultural villages; nearly every family is in fairly comfortable circumstances. Here is a great opportunity for promotional work which will benefit the public.

The following interesting data on the sewerage of small towns in Illinois are from a paper by Mr. M. C. Sjoblom, Assistant Engineer, Illinois State Department of Health, presented at the 1920 annual meeting of the Illinois Society of Engineers:

The following data, though not exact to the last town, give the approximate number of towns sewered and without sewerage. The population figures given are taken from the 1910 census. A number of the towns have doubtless grown in population so that they do not now fall within the classes in which they are placed. However, this simply makes conditions worse than actually presented here.

Population	No. Villages and Cities	Have Sewers	Without Sewers
Below 500	416	0	416
Between 500-600	87	2	85
Between 600-700	69	4	65
Between 700-800	53	2	51
Between 800-900	29	1	28
Between 900-1,000	37	3	34
		12	679

The situation among cities having a population over 1,000 is as follows: There are a total of 189 cities which have sewerage systems. Of these cities there are 87 which have a population of 4,000 or over so that there are only 102 cities between 1,000 and 4,000 which have sewerage.

There are 160 cities and villages with populations of over 1,000 which are without sewers. This list may be classified as follows:

Population	No. of Cities and Villages without sewerage
1,000-1,100	32
1,100-1,200	24
1,200-1,300	12
1,300-1,400	14
1,400-1,500	11
1,500-1,600	10
1,600-1,700	6
1,700-1,800	0
1,800-1,900	6
1,900-2,000	6
2,000-2,500	20
2,500-3,000	11
3,000 and above	8
	160

If a detailed study were made of the entire state, it would doubtless be found that the above figures indicate conditions far better than actually exist. Such a study would doubtless show, also, a large number of the towns sewered but partially, which are credited with sewers, and many others to have systems which are not worthy of the names of sewerage systems.

THE PRESENT HIGH COST OF MONEY TO PUBLIC UTILITIES

By Dow R. Gwinn, President and Manager, The Terre Haute Water Works Co., Terre Haute, Ind.

In these days of extremely high cost of living, when the cost of provisions, clothing, coal and other commodities has reached a high altitude, the cost of money has also materially increased. The average citizen who has observed the great advance in prices of groceries, meat, clothing and shoes, has probably failed to note that the cost of water, gas, electricity and street car service has not advanced in the same proportion.

And while some workmen have had a period of wild extravagance, indulging in $15 silk shirts, the average salaried man has been so busy trying to stretch his income to meet the rising cost of living that it is not surprising that he has not had time to consider the difficulties under which the public utilities are struggling. The word "struggling" is used after due consideration.

Cost of Water Works Operation

While the title of this article indicates that it will deal with cost of money, the author will take the liberty of stating that a compilation made by him shows that since 1914 the average increase in the cost of 29 items entering into the operation of a water works plant was 86.7 per cent. The average increase in the cost of labor at the Terre Haute plant since 1914 is 63 per cent. The increase in common labor has been approximately 100 per cent.

As a matter of fact, cost of operation does enter indirectly into the cost of money, for when there is a big increase in cost of operation without an increase in gross earnings, there is a reduction in net earnings which may materially affect the attractiveness of bonds. And if bonds are not attractive to the buyer, he will expect a larger discount, which means a higher cost to the utility for the money he rents.

Where the utility must filter and sterilize water, the cost of operation is subject to an unusual increase. It is necessary to maintain the standard of purity regardless of cost or dividends.

The company whose bonds matured since the United States entered the great war was extremely unfortunate. The necessity for money for war purposes was so great that the rate of interest on Liberty bonds was raised again and again. When the investor can buy 4¾ per cent. Liberty bonds at less than par, he has no interest in the average utility bond, unless the security is ample and the return much higher than from government bonds.

Re-financing

The author is familiar with the re-financing of a water company whose 4½ per cent. 20-year bonds matured last June. There was approximately $1,000,000 outstanding. It was necessary to issue $1,035,000 6 per cent. 5-year securities, which were sold at 94, or at a discount of 6 per cent. The company is required to pay into a sinking fund, out of surplus earnings, $20,000 per annum for retiring the securities.

The annual interest charge was increased $17,100; that is, from approximately $45,000 to $62,100. The discount, when amortized over the 3-year period, amounts to $12,420 per annum, making an increase in the cost of money to the company of $29,520 per annum.

However, there were other costs in connection with the issue of the securities, such as attorney fees for preparing the trust deed and other papers, traveling expenses, revenue stamps and printing; the fees to the State amounted to $2,087 for authority to issue securities. The company assumed the income tax up to 2 per cent. on the bond interest.

Outside of these extra costs, which were kept at the minimum, the cost of money to the company is 7.63 per cent. Including the additional expense, the cost is almost 8 per cent.

In five years from the date of issue the whole program must be repeated. It is to be hoped, however, that the cost of money at the time of maturity will be lower than at present. Fortunately for the company, the Public

Service Commission authorized an increase of rates, which has been a great help, although the increase was not as much as was asked for or what the company thought it was entitled to.

Rate for Interest and Return

To show that the case referred to is not an unusual one, the author will state that public utility securities have been offered recently to yield the investor in the neighborhood of 8 per cent. This would mean that the cost to the utility for money would be considerably more.

When a utility must pay 8 per cent., and in some cases 10 per cent., for the use of money, how can it be expected to do business and furnish satisfactory service on a 7 per cent. rate of return?

The securities of the Toledo Traction, Light and Power Company were recently offered to yield the investor 8 per cent. It means that the cost to the utility would be even more than that high rate.

The securities of the Cincinnati Gas and Electric Company have recently been offered to yield the investor over 8 per cent.

The Brooklyn Edison Company also issued some securities that will be due in 1930, which were offered to yield the investor 7 per cent.; the discount and expense must be taken into account to get the actual cost to the utility.

The author has a list of about a dozen large utility concerns, the securities of which were offered to yield 7.55 per cent., 8, 7, 8, 7.8, 7.75, 7.75, 7.75, 7.5, 7.18, 7.5 and 7.8 per cent. This will give an idea of the yield to the investor, but it should be borne in mind that the additional cost to the utility is greater than the figures mentioned.

The additional cost depends on the money market, the life of the bonds or other securities, the standing of the utility, the record of earnings, etc., etc. The banker who buys the securities must maintain a selling organization, and there is the expense of investigation, examination of properties, audit, legal opinions, and also overhead expense.

A prominent financial writer, in a recent review and forecast, stated:

"Careful attention, however, should be given to fare and rate regulation and limitation, which has caused the downfall of some of the strongest companies in the country during the past few years of rising costs and restricted incomes. Many traction companies have been crucified on the altar of political stupidity."

Some Relief to Traction Companies

Some traction companies have been granted relief. It is shown in a statement recently published that fares have been increased in 460 cities. The 10 ct. fare now prevails in 59 cities. Unfortunately, 48 companies went into the hands of receivers in the year 1919, and in the past three years 98 companies were involved in bankruptcy.

Property that is dedicated to the use of the public should be treated fairly and liberally, otherwise capital will seek other investments. Unless the rate of return is such as to attract capital, the property cannot be improved and needed extensions made. The result is that the public suffers. The public is willing to pay reasonable rates for good service. An inadequate rate of return not only hurts the utility, but it hurts the public.

A Sensible View of Financial Matters

The author was interested in a decision rendered April 18, 1916, by the Railway Commission of Wisconsin, in the case of Peter S. Bogard vs. Wisconsin Telephone Company. Here are a few extracts from the decision which show the sensible way the Wisconsin Commission looks at these financial matters:

"The cost at which capital can be had depends upon the market rate for money in similar undertakings. * * * During the past decade the cost of capital and of the other elements mentioned for public utilities generally, which are operating under conditions that may be regarded as normal, has ranged from about 7 per cent. to more than 9 per cent. on the fair value of the plants and their business. * * * When the net earnings available for returns have amounted to at least twice as much as the interest charges on the bonds, the cost of obtaining the money has not often been less than about 6.5 per cent. When that part of the capital, which is thus comparatively well secured, costs as much as this, it is rather obvious that the balance of the capital over and above that part which is thus represented by the bonds, must cost a great deal more. In fact, experience shows that for the latter part the cost is often from two to three times as great as for the former part. This is certainly true when the investment is based on commercial considerations alone. The cost of the capital needed is a part of the cost of the service that in the long run must be borne by the consumer if the service is to be furnished. This cost, like most other costs, is fixed in the open market by economic forces over which individuals and companies have little or no control. * * * In many of its decisions, where the conditions were normal, the Commission has found the reasonable rate of return to which utilities should be entitled to be from 7 to 8 per cent. of the fair value of the property and business. We believe that in the present case * * * the latter rate of return is fully justified."

It should be noted that the decision from which the extracts were taken was rendered April 18, 1916, or nearly four years ago, when the demand for money cannot be compared with the present great demand and high cost.

Liberal Treatment Is Absolutely Necessary

Water companies and departments have been given some relief, but in a general way it would seem that the relief has not been in proportion to the rate of increase in the cost of operation and in the cost of money.

In justice to many commissions it may be stated that they are making a conscientious effort to give the necessary relief, and it is to be hoped that the vision will be broad and clear; that the Public Service Commissioners will realize that if service is to be continued and of proper standard, that liberal treatment in the way of return is absolutely necessary; that in order to borrow money to make extensions and improvements it is necessary for the utilities to make a reasonable profit in addition to mere interest; that the public should be protected in the way of securing service as well as in the matter of rates; that the public will not be benefited by driving private ownership from the utility field; that with money costing 8 to 10 per cent. and a rate of return of only 7 per cent., the end will not be long postponed.

Extracts from Liberal Commission Views

In conclusion, extracts from several Public Service Commission decisions and also one report will be given.

Judge Thomas M. Cooley, first Chairman of the Interstate Commission, in the report for 1888, page 22, gave expression to the following:

"The public can never be in the wrong in demanding good service when fair rates are considered; an enlightened public sentiment will never object to fair rates when it is understood that good service is conditional upon them."

The following is an extract from a decision of the California Railroad Commission in City and County of San Francisco v. Pacific Gas & Electric Co. Decision No. 4736, case No. 839, P. U. R. 1918-A, January 31, 1918:

"The Commission, in fixing a rate of return, must be liberal, lest too strict a portion result in turning capital to other fields of enterprise. In this case we shall recommend rates which to the best of our judgment will yield to the company a return of 8 per cent. on the fair value of the property used and useful."

Wisconsin Railroad Commission in Re: Milwaukee Electric Railway & Light Co., P. U. R. 1918-A, February, 1918, 798, appears the following:

"Increases in rates necessary to enable a public utility efficiently to perform its public obligations and to render public utility should not be allowed to decrease owing to abnormally high operating costs until a point is reached where a question of difficulty to meet fixed charges is seriously presented."

In the case of the New York Public Service Commission, 1st District, Re: New York & North Shore Traction Co., No. 2217, decided January 10, 1918, P. U. R. 1918, February, 893, it was stated:

"The State, through the Commission, endeavors to see to it that upon the business done by the company, rates reasonable for the service and productive of a reasonable revenue, are charged. Otherwise the company must go out of business or rely on the charity of investors. It is obvious that any business, to continue, must have a revenue that will do more than meet the mere cost of currently running the business. * * * There is no way of getting something for nothing over a long period of time."

In a decision by the Oregon State Public Service Commission, handed down January 5, 1918, pertaining to the Portland Railroad, Light and Power Company, it was stated as follows:

"It is time for the public to realize that the powers conferred upon public service commissions, thoroughly tested and upheld by the courts, are ample for the protection of the public against all the evils from which they suffered in the past. * * * It is time also to realize that good service can be obtained only by just and equitable treatment. * * * No starved horse ever pulled a heavy load. * * * The utilities have been deprived of the power to make unjust profits. They must also be protected against unjust losses. * * * If a utility is driven into a position where its credit is impaired and it can obtain money for operations and extensions only at unreasonable cost, the public must share the loss."

The foregoing paper by Mr. Gwinn was presented before the recent annual meeting of the Illinois Section of the American Water Works Association.

FUNDAMENTAL CONSIDERATIONS AFFECTING CONCRETE PAVEMENT DESIGN

The article with the foregoing title, contributed to the February issue of Municipal and County Engineering by S. T. Morse, city engineer of Carlinville, Ill., has attracted favorable comment. Three of the letters to the editor, commenting on the article, follow.

Irving W. Patterson, chief engineer of the Rhode Island State Board of Public Roads, writes:

"The article impresses me as one of the most interesting technical articles upon the design of concrete pavements that I have read. It seems to me, however, that a feature of design which might be covered more fully is the relationship between depth of slab and subsoil conditions. We pay the greatest attention to the study of subsoil conditions. This feature of our work is described to some extent in an article by me appearing in the issue of Engineering News-Record, published Dec. 20, 1919. It seems to me that treatment of unfavorable subsoil conditions is one of the most necessary features of design of any type of pavement. I appreciate the fact, however, that the treatment of subsoil defects may not be considered properly as a feature of pavement design. It seems to me, however, that the most careful design of the pavement proper is of little avail without an equally careful study of subsoil conditions."

H. K. Bishop, chief engineer, Indiana State Highway Commission, writes:

"I have read this article over carefully and I believe that Mr. Morse has an interesting article and has brought out some very good points.

"Due to the fact that my graduation from college dates back about 25 years, I have had a little difficulty in following all of Mr. Morse's mathematical deductions. However, I believe the result obtained as shown in Table 1 at the foot of page 65 gives the thickness of pavement consistent with our experience.

"Mr. Morse's conclusion that we are coming to a 1:1:2 mix may be right, but I have some doubts. It would seem to me that the improvements made in the mixing and finishing of concrete will enable us to use the leaner mixes and obtain good results. The use of a good type of finishing machine, with a proper tamping device, enables the use, I believe, of a slightly leaner mix to obtain equal results.

"The author in Table 1 gives the proper thicknesses for a 16-ft. concrete road with a 1:1½:3 mix as 8.17 ins., and for a 20-ft. road as 10.4 ins. Interpolating for an 18-ft. road, we would have an average thickness required of something over 9 ins. While this conclusion would meet with our approval, we are governed by other considerations.

"Mr. Morse's theory assumes that we have plenty of funds. Practically, we are usually limited on the width and thickness of pavements to what public opinion will stand. In Indiana we are constructing one-course concrete roads, 6 ins. at the sides, 8 ins. at the center and 18 ft. wide, giving an average thickness of 7 1/3 ins. These roads are costing us from $35,000 to $40,000 per mile. This seems to be about all the public will stand for at this time.

"It would seem to me that the character of the foundation and treatment by under-drains might possibly have a little more bearing on the thickness of the slab than that allowed for by Mr. Morse's formula.

"Where we have been unable to get satisfactory subgrade conditions the thickness of slab which we are building under the traffic conditions which we have has given good results. I admit that it would be better to have the additional thickness recommended by Mr. Morse's formula, but I doubt if we could persuade the authorities of this State to increase the cost due to this additional factor of safety.

"We are, therefore, struggling along, trying to improve the sub-base conditions and other factors which will allow us to use a thinner slab. It has been our experience, and I think will be corroborated by Delaware, that a uniform sub-grade obtained usually by ploughing to a depth of 10 or 12 ins. will eliminate the longitudinal cracking.

"Theoretically, I think we are wrong in our design of roads of this type. There is quite a desire to standardize road construction, and slabs of uniform thickness are adopted irrespective of subsoil conditions or consideration of the traffic, both present and future.

"The standard design requires less labor in the prepration of the plans, which is perhaps a greater convenience. We attempt to standardize the design of the road metal itself and prepare our foundations where necessary so that conditions of sub-grade are equal. This process overlooks, however, the question of traffic altogether.

"I believe the practice in most states is to standardize their designs, although some states allow a different thickness for different traffic conditions. In Indiana our variation in traffic is not so great as in some of our sister states and a consideration of this is less important.

"In conclusion I wish to say that I think Mr. Morse has brought out some good thoughts here and has treated this subject in a thoroughly scientific way. I believe that his conclusions are on the safe side and that where practicable the results obtained from Equation No. 5 in the rational design of the central thickness of concrete pavement slabs should be followed."

Mr. W. D. P. Warren, of Miller, Holbrook, Warren & Co., Civil Engineers, Millikin Bldg., Decatur, Ill., writes:

I have read the article, "Fundamental Considerations Affecting Concrete Pavement design," by Mr. S. T. Morse, published in the February, 1920, issue of Municipal and County Engineering, and find his discussion one which adds much of interest to available data on this important subject.

He very forcefully directs the attention of the profession to the fact that concrete pavements should be designed, and that such design should be governed by certain known engineering principles and the application of such local data and information as may apply. While there may be other factors which will affect the design, I believe the considerations stated are of such vital importance that recognition of them will go far toward the solution of some of our present paving difficulties.

The fundamental considerations will be discussed briefly as follows:

Foundation

The writer has observed over a period of years that a rigid slab of concrete, such as a concrete sidewalk, a concrete pavement, or a monolithic brick pavement, is subject to longitudinal cracks, and that such cracks develop to a greater degree as the width of slab increases.

We avoid this in concrete sidewalk construction by cutting our blocks, usually specifying that blocks only 4 ins. in thickness shall not exceed 5 ft. in width.

Experience in sidewalk construction is that a 4-in. walk over 6-ft. in width will invariably develop longitudinal cracks.

The same principle will hold true in concrete pavement construction where the vertical movement of the earth at the sides, due to the effect of moisture, will cause the slab to be subjected to longitudinal stresses. The allowance for this stress in design may be made either by increased thickness of slab near the center, depending upon the width, or by use of a longitudinal joint. The construction of such a joint certainly has some objectionable features, although not serious on certain widths of pavements, when it is considered that separation of lines of vehicles is now advantageous.

Weight and Speed of Moving Loads

Consideration of the pressures due to impact have been less essential with some other types of pavements, but with the concrete type impact should receive careful anaylsis and proper allowance should be made for it.

Recent experiments conducted along these lines generally bear out the values submitted.

Strength of Concrete

Regarding the preference of a 1:1:2 mix over a 1:2:3, it is thought that possibly a 1:2:3 mix will generally be found more practicable. It is the belief of the writer on this point that tougher aggregates and scientific grading will secure a satisfactory strength of concrete and, in fact, an economical strength.

Width of Pavement

This was discussed briefly under the heading of Foundation, and it is desired now to direct attention again to this important detail of design.

Engineers as a rule recognize the fact that any type of pavement will require regular maintenance. Practically all our state highway departments and most of our cities of any size have recognized the necessity of constant, well directed maintenance, and yet we are still endeavoring to design pavements which will require little or no maintenance.

Consideration of this fact should be of great value just here. Shall we undertake so to design and construct a pavement in certain details that it will positively require maintenance? This has been done in practically every type of engineering structure, and, as an example, we have in the elimination of our transverse joints in concrete pavements, and the maintenance of resulting transverse cracks, admitted the wisdom of such practice. Shall we now design concrete pavements of certain widths and in certain locations with a longitudinal joint and assume that we can either properly protect the joint or maintain it at an economical cost?

Conclusion

The writer feels from a study of Mr. Morse's article that he has given this subject much thought and that his discussion should enable the profession to obtain a clearer

understanding of the considerations affecting the design of concrete pavements.

I have had opportunity to observe the action of concrete pavements under varying conditions and believe that recognition of the fundamental principles that govern concrete as a structural and paving material will enable us to build concrete roads and streets at a reduced cost regardless of the present high prices of labor and material.

NEW INSTITUTIONAL SEWAGE TREATMENT PLANT AT WEST FALLS, VIRGINIA

By George L. Robinson, Consulting Engineer, 37 East 28th St., New York City

The accompanying drawing indicates a sewage disposal plant which was designed by the writer and is now being installed for the School of the Sisters of Perpetual Adoration at West Falls, Va.

This plant is interesting chiefly because its design was necessitated by the restricted grades. The stream into which the effluent flows is at such an elevation with relation to the new buildings that it prohibits the use of sprinkling beds.

There will be about 300 children at this school—mostly boarders—and the sewage production is estimated at about 10,000 gallons a day.

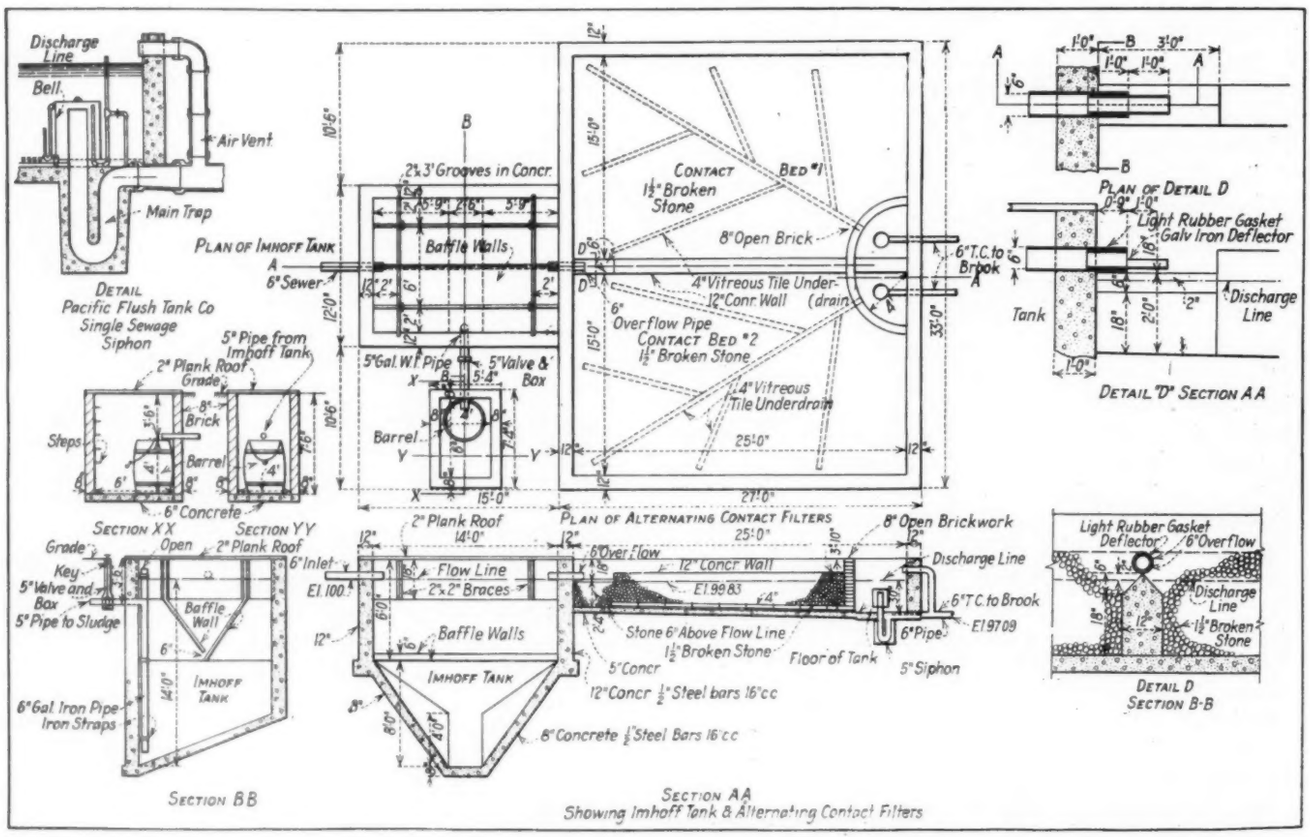
The plant consists of a modified Imhoff tank, the sludge compartment sloping to one side and the cast iron sludge removal pipe being valved in such a way that the sludge, when it accumulates, can be turned off into a large barrel contained in a masonry pit adjacent to the tank; the sludge being removed in the barrel to some point on the farm where it can be buried or used for fertilizing purposes.

The effluent from the Imhoff tank passes over into either of two contact beds. The control of the flow into either or both beds is shown in the detail drawing. The arrangement consists of galvanized sheet iron half pipe cut away from a section of full pipe. This piece is inserted into a 6-inch overflow pipe from the tank and is held in place by a light rubber gasket. By tipping the half pipe in either direction the flow from the Imhoff tank will pass into either of the contact beds. By removing this galvanized half pipe entirely the flow will strike the angle on the division wall so that the water will pass into both beds simultaneously.

Each contact bed is provided with an automatic Miller siphon. These siphons are not related and they discharge independent of each other. The overflow arrangement from the Imhoff tank permits the siphons to operate in rotation or continuously.

Although no sterilization outfit for the effluent is shown, it is understood that a chlorination plant may be installed at a later date if necessary.

The dimensions of the Imhoff tank and the contact beds are shown clearly on the drawing and follow the usual practice as to capacity.



DETAILS OF DESIGN OF A NEW INSTITUTIONAL SEWAGE TREATMENT PLANT AT WEST FALLS, VIRGINIA.

DESIGN AND OPERATION OF MOVABLE CREST DAMS

By Wm. G. Fargo, Fargo Engineering Company, Jackson, Mich.

If in the construction of dams, solid overflow weirs or rollways are used, there must be provided a freeboard height at the dykes, embankments, abutments, power houses, and other adjacent structures, equal to the maximum expected flood rise, plus a safety margin. The flowage land purchased must also extend above such expected flood contours, otherwise damage claims arise. Moreover, if floods are allowed to rise over a spillway crest, this will operate to reduce at such times the head of the next dam above, if it is close by. It is therefore frequently important to provide large waterways through dams by means of gates and similar devices.

Means for lowering the crests of dams and controlling openings through dams may be for the most part categorically placed in the following leading classes. It should be borne in mind that there are various gates combining two or more of the various elements or principles involved.

Classes of Gates and Movable Weirs

I. Needle dams
II. Slide gates
  (a) on crest
  (b) deep sluices
III. Pivoted or hinged gates and flashboards, including:
  (a) Various "bear-trap" types
  (b) Tainter (or sector gates) and drum gates
IV. Rolling gates, including:
  (a) Cylinders
  (b) Shutters of polygon section mounted between large wheels or rollers which traverse inclined tracks.
V. Siphon spillways.

Means for Operating Gates

Small gates are opened and closed manually, as are also gates of considerable size, through the interposition of trains of gears or equivalent devices. Where quick operation is desired for large gates, power operation is necessary and motor drives are commonly used. On many of the old water-power systems of New England the gates, and especially feeder canal head-gates of the sliding type, are often operated by water turbines directly geared to lineshafts which have shift gears on clutches to engage the individual gate hoists, of which there may be a considerable number, perhaps 20 or 30 on the large power canals.

Bear-trap gates of the Marshall, Lang, Parker and other types are operated directly by hydraulic means. These gates consist essentially of two or three leaves of steel or timber, hinged together in a series, working betwen parallel side walls. By admitting water under pressure due to the head on the dam to a chamber underneath the leaves, they rise in "A" shape and drop when the downstream outlet valves are opened, lying collapsed and flat on the bottom of the wasteway. Auxiliary protecting leaves cover the joints and keep out debris. Chains restrain the movement of the principal leaves. See Fig. 1 for line drawings of Lang and Parker types of bear-trap gates.

Automatic Gates

Various types of gates which can be balanced may be made automatic and control the level of the headpool within a few inches. Siphon Spillways may also readily be made automatic in operation. Shutters or flashboards pivoted horizontally at about one-third of their height will

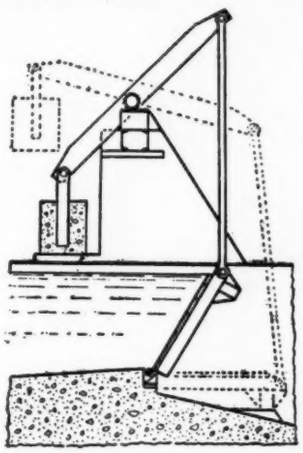


FIG. 2.

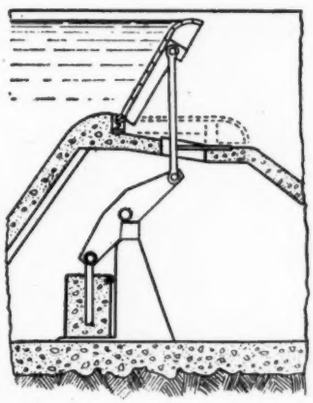


FIG. 3.

FIGS 2 AND 3. RECTANGULAR LEAF GATES HINGED AT BASE. PATENTS OWNED BY BARRAGES AUTOMATIQUES S. A. OF ZURICH, SWITZERLAND.

tip when the water rises over their top edge. Such gates do not give, however, an unobstructed passage for the water, and are liable to become clogged with debris. Rectangular leaf gates hinged at the base and sometimes called bear-trap gates are shown in Figs. 2 and 3. These are a good type of automatic gates, giving a free crest when open. The patents on this type are owned by Barrages Automatiques S. A., of Zurich, Switzerland. Three

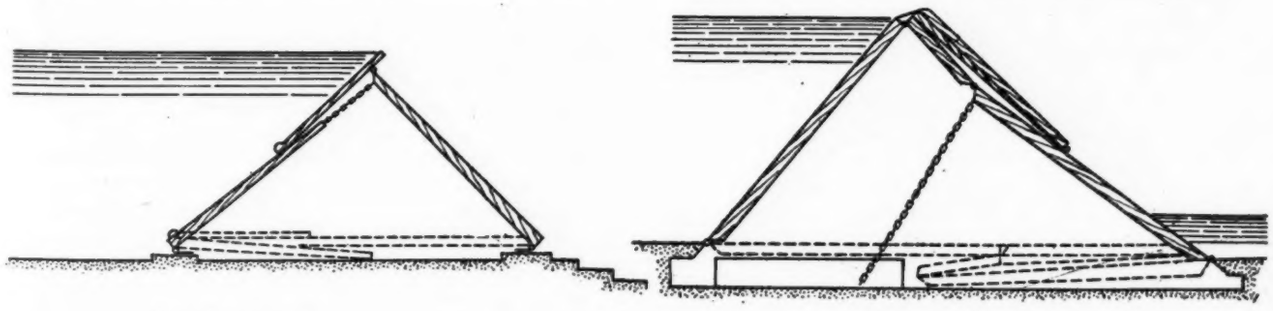


FIG. 1. ESSENTIAL FEATURES OF THE LANG AND PARKER BEARTRAP GATES.

installations of this sort have been made in the United States.

Cylinder Gates, Automatic and Otherwise

The Carstanjen rolling cylinder gate promoted by Maschinenfabrik Vereingte, Augsberg-Nurnberg, Germany, is also an interesting type adaptable to long crests. The principle of this is shown in Fig. 4. A similar gate has been patented by J. E. Jenkins, of New York, which operates directly by the pressure of the water, and is therefore automatic. The Carstanjen gates are operated by sprockets. There are now four installations of these rolling cylinder gates in the United States. One near Spokane, Wash., at the Long Lake plant of the Washington Water Power Company, designed by Machinenfabrik, has three of these cylinders, each closing an opening 65 ft. by 19 ft. Another gate of this type, 30 ft. by 8 ft., is

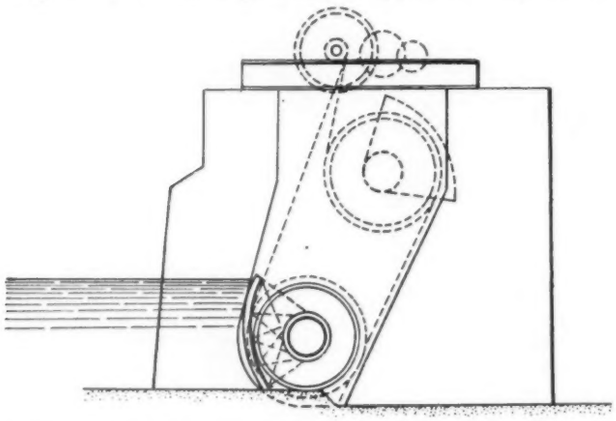


FIG. 4. THE CARSTANJEN ROLLING CYLINDER GATE ADAPTABLE TO LONG CRESTS.

in use near Boise, Idaho. The Grand Valley Reclamation Project, in Colorado, has six similar gates, 70 ft. x 10.25 ft., and one 60 ft. by 15.3 ft.

Tightening Devices

Gates which, like the slide gates, are held by the water pressure in contact with a frame, are water-tight so long as the contact surfaces are in good condition, with no foreign matter separating them. One of the surfaces in contact should be of bronze to reduce friction and prevent rusting tight.

Gates which are hinged are usually provided with flexible flaps of metal, leather, rubber or canvas belting over the joints. Tainter gates are also tightened at the side joints in this manner, usually by rubber fabric strips of 5 to 8 plies, and 6 to 10 ins. wide. These strips accommodate themselves to the curve of the gate, and under the pressure of water lie in a small radius curve against the gate piers. These piers at the arc of travel of the gates must therefore be smooth and true. The bottoms of Tainter and slide gates are frequently fitted with a timber sill. This has the advantage of being easily fitted to the masonry or steel sub-sill on the dam crest, but it has the serious disadvantage of being easily injured or torn off by ice and heavy debris passing with flood water.

A steel sill on the gate properly fitted to the concrete dam crest by forming the concrete against the gate sill itself is now thought to be a better detail. For the side tightening of Tainter gates a flexible bronze or thin steel plate is more permanent than belting and is standard practice in Europe.

Stoney gates, which are large slide gates carried on roller trains, are often tightened at the sides by a "staunching rod," see Fig. 5, which may be a piece of shafting 2 or 3 ins. in diameter, held in a "V"-shaped groove by the water pressure. One face of this "V" groove is fast to the gate and the other to the pier. The "staunching rod" is therefore only in contact along two vertical lines on the periphery of this piece of shafting. If the surfaces are true, this is a fairly satisfactory means of securing a water-tight joint. The shape of the groove with the contained cylinder forms a pocket for retention of silt and fine fibrous materials which are naturally drawn in by slight leaks past the cylinder, and this soon makes a tight joint. It would not be difficult to bend a piece of shafting to fit the side of a Tainter gate, but the machining of the "V" strips and securing them permanently in their correct positions is a more difficult matter.

If a Tainter gate side joint could be devised that would be more permanently tight and less subject to injury than the strips of belting now mostly used, this form of gate would be a very satisfactory gate for medium and large openings.

Hints to Operators

General Inspections—When gates are ordinarily submerged and can only be inspected when they are raised to pass flood, this opportunity should be taken advantage of to make inspection as to the condition of any parts of the gates which may then be readily reached. Steel Tainter gates should have their upstream surfaces carefully inspected for rust and more serious tuberculation, and if they are to remain open long enough to permit, a suitable

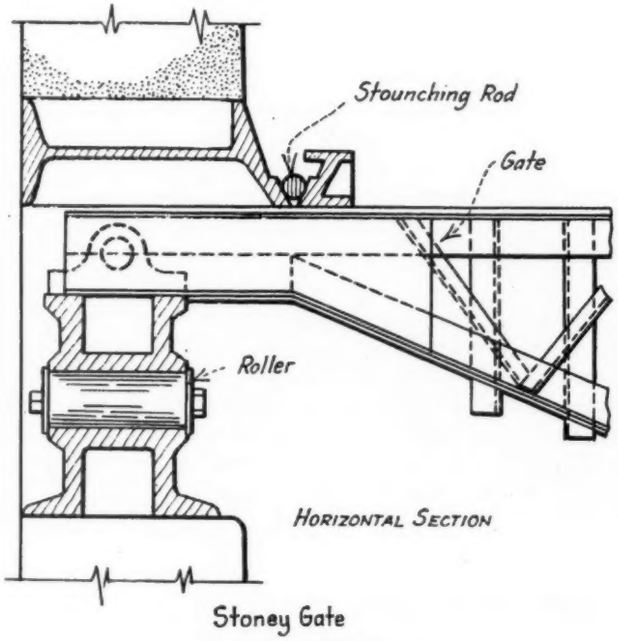


FIG. 5. STONEY GATE.

paint should be applied. Bituminous paints have, on the whole, been found to be the most satisfactory for painting surfaces of submerged gates or other steel which is in the water. It is necessary, however, to apply such paints to dry surfaces and preferably during warm weather.

Tightening strips should be inspected and replaced if needed, and the sills attached to gates also given attention. It is important that gates should be made as tight

as their design will permit, to avoid loss of water and consequent loss of power, and particularly to prevent accumulation of ice in the winter on the downstream side of the gate.

Winter Operation of Gates—Whenever floods are commonly expected during the winter months some of the gates should be kept thawed or in such condition that they can be opened within the time permitted by the usual rising time of the flood. Where there are not to exceed six or eight gates, the two end gates and possibly one central gate only will be kept thawed, as it is found within an hour or two after two end gates and possibly one central gate are opened, the movement of warmer water along the upstream faces of the other gates will also thaw these gates.

FIG. 6. UNDERHUNG COUNTERWEIGHT AUTOMATIC GATE AT OSFALDET (ROROS) NORWAY.

In chopping out gates in the winter, proper care must be exercised to avoid injury to the tightening strips. In thawing gates without steam-heating apparatus built into the gate face, care must be taken not to overheat any steel members on the downstream side of the gate, such as struts and arms of Tainter gates, by building open fires in close proximity to such member. Overheating these members might cause sudden buckling and collapse of the gate.

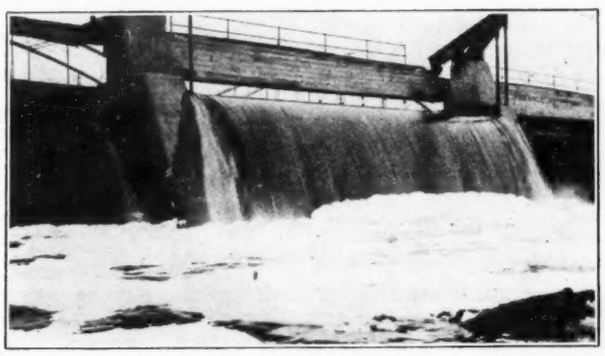


FIG. 7. OVERHEAD COUNTERWEIGHT AUTOMATIC GATE AT NASHUA, IOWA. SIZE 46 x 7 FEET. INSTALLED BY FARGO ENGINEERING CO.

Gate Hoisting Mechanisms—These should be periodically inspected by competent mechanics and all bearings put in alignment, cap bolts on bearings and elsewhere tightened, oil baths cleaned and replenished and worms inspected to know that there is no cutting. Ball bearings need careful inspection to insure that the ball races and other parts are in proper adjustment, lack of which will result in crushing of the hardened steel balls and consequent loss of the entire bearing by grinding caused by any such broken parts. Hoisting chains must be frequently inspected to see that no undue stretch has occurred which would both weaken the chain and perhaps unbalance the operation of the hoist if the gate is hung on more than one chain. Thus, if the chains are not of equal length the gate may jam at one end between the piers.

Steam-Heated Gates

It is now common practice to inclose a space on the downstream side of Tainter gates and to heat this space by means of steam coils within. Steam is fed to these coils by a swinging pipe centered in line with the gate pins. Low-pressure steam from the power-house heating system is entirely sufficient to keep the gate thawed out all winter. Such heated chambers may readily be supported by the gate arm and swing with the gate. The roof of the chamber should be made of steel plate so that any water spilling over the gate will cause no injury. Steam chambers have sometimes been inserted in the masonry piers and made to conform to the line of travel of the gate. In the case of Tainter gates such steel chambers would form the side bearing and smooth surface for travel of the tightening strips. In the case of mechanically operated bear-trap leaves, the side chambers, if used, would be inclined in the piers and would also form the bearing surface for the tightening when the gate is in its raised position.

It is to be expected in most climates that when the gate is spilling it will keep itself free. The best form of applying heat is by heated chambers, either fixed or moving with the gate, located on the downstream side or underneath the gate so as to keep warm the surface of the gate which is in contact with headwater.

Automatic hinge leaf gates of the underhung counterweight type are in successful operation at Osfaldet, Norway, within the Arctic circle, see Fig. 6. An overhead counterweight automatic gate, 46x7 ft., installed by the Fargo Engineering Co., at Nashua, Ia., is shown in Fig. 7. Tainter gates, 24x13 ft., in the dam of the Five Channels hydro-electric plant of the Consumers' Power Company, on the Au Sable river, in Michigan, are shown in Fig. 8.

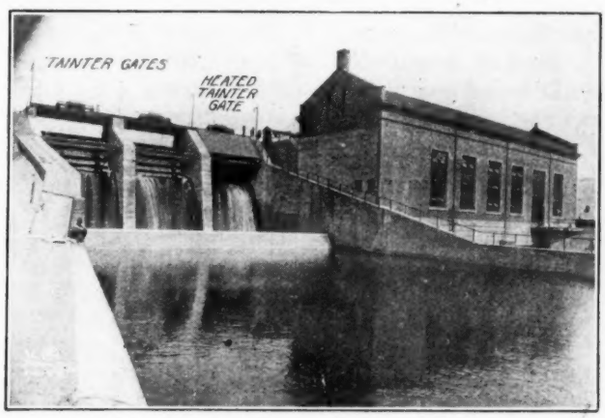


FIG 8. "FIVE CHANNELS" HYDRO-ELECTRIC PLANT OF THE CONSUMERS' POWER COMPANY, AU SABLE RIVER IN MICHIGAN, SHOWING 24 x 13-FT. TAINTER GATES.

NEW HIGHWAY TESTS BEING MADE BY THE BUREAU OF PUBLIC ROADS

By A. T. Goldbeck, Engineer of Tests, Bureau of Public Roads, Washington, D. C.

(Editor's Note:—The Bureau of Public Roads has been conducting a number of investigations on the effect of modern traffic on hard-surface roadways, and related problems, and in previous issues of this magazine the results of the tests made to determine the amount of impact delivered by motor trucks on roads have been recorded in brief form. The present article, extracted from the paper by Mr. Goldbeck, as presented at the recent annual meeting of the American Road Builders' Association, refers to the other major investigations the Bureau is making.)

A Study of the Effect of Impact on Different Types of Road Surfaces

A knowledge of the force delivered to a road surface by traffic of itself is not of very great value unless we can couple this information with the effect of that force on different types of surfaces. We are therefore conducting a series of tests with this idea in view, namely, determining the effect of impact on different kinds of road surfaces. For carrying on this investigation we have constructed a number of slabs 7 ft. square and laid directly on the subgrade. These specimens include concrete slabs of 1:1½:3 mix, 2, 4, 6, 8 and 10 ins. in thickness, and several slabs 14 ft. square, 6 ins. in thickness. We have a number of different types of brick slabs built with wire-cut lug, repressed and also vertical fiber brick. Some of these are laid with sand-cushion construction, some with monolithic and some with semi-monolithic construction. We have used sand cushion and also bituminous mastic cushion. We have likewise used several different types of filler, including cement grout, bituminous filler and bituminous mastic filler. The concrete base is 4 ins. under some of the slabs and 6 ins. under some of the others. We have likewise constructed slabs with 3-in. wire-cut lug brick, monolithic construction with 3-in. and 4-in. concrete bases. We have also constructed a few slabs laid on 6 ins. and 12 ins. of macadam. We aim to continue these tests, using a large number of different types of construction that may look promising.

Impact Machine

The above slabs will be subjected to impact by means of a special machine constructed for that purpose. It is designed to give impact conditions similar to those given by the rear wheel of a heavy truck. In its present form the machine consists of a 2,000-lb. weight, shod at the bottom with a 12-in. solid rubber tire and carrying a 6,000-lb. weight supported through the use of a single heavy truck spring. The entire weight of 8,000 lbs. may be raised by means of a cam gear-driven by gasoline engine, so that repeated impacts may be delivered at one spot on the slab until failure takes place. We have instruments mounted on the machine which autographically show us the deceleration or suddenness with which the weight is brought to rest upon the slab. From these curves it is possible for us to measure the exact force of the impact. We likewise have instruments to enable us to measure very carefully the deformation of the slab under the repeated blows of this machine.

As the condition of the subgrade will undoubtedly affect the load-supporting value of the surfacing, we have constructed duplicate sets of specimens, one set of which is laid on a subgrade which will be purposely kept in a moist condition and therefore be of low bearing value, and the other is laid on a subgrade which we will endeavor to keep dry and thus obtain a high bearing value. From the results of these tests we should be able to say just what types of roads may be considered as comparable so far as their resistance to pounding of heavy trucks is concerned.

A Study of the Effect of Traffic on Different Types of Road Surfaces

We are conducting still a third series of tests which were designed primarily to enable us to develop suitable laboratory tests for stone paving block, but which we are using incidentally to give us some idea of the relative wearing qualities of different types of surfacings when they are all subjected to exactly the same traffic.

We have constructed a straight-way track, 400 ft. in length and 2 ft. in width, in which are laid 49 different sections of pavements. As at present constructed, these sections include concrete having different kinds of coarse aggregates, including trap rock, gneiss, gravel, soft sandstone, limestone and air-cooled blast furnace slag. There are a number of different kinds of brick pavements in which brick having different perentages of wear are used, the percentages being 16, 19 and 24 per cent. in the rattler test. There are likewise sections in which 3-in. brick are used. Both sand cushion and semi-monolithic construction have been employed. The type of filler has also been varied to include cement grout and bituminous fillers. There are also a number of stone block sections constructed of block from different parts of the country. The filler has likewise been made to include bituminous as well as Portland cement fillers.

Over these sections a wear machine is hauled by means of a cableway. This machine consists essentially of five large cast iron wheels, each weighing 1,000 lbs., with a tire width of 2 ins. Each of these wheels is perfectly free and independent from the remaining wheels, and its full weight is exerted on the road surface. They are so arranged that they travel over a strip 12 ins. in width, and there is considerable impact action exerted by the heavy unsprung weight of these wheels, and the action of this device is rather one of heavy impact than abrasion. Although the machine has made less than 2,000 trips at the present writing, several of the weaker types of pavements have shown signs of failure.

A Study of the Bearing Power of Subgrades as Affected by Moisture

It is common knowledge that whereas city pavements may stand exceedingly heavy traffic, those same pavements, when laid on country highways, develop weak spots and defects which require considerable maintenance. The difference between the city pavement and the country highway very obviously is that of drainage. The subgrade under city streets is generally in very much better condition than that of country highways, because it is possible to keep the subgrade under city streets very much drier than the subgrade under country highways.

The bearing value of most soils is very greatly decreased by the presence of water, and one of our greatest

problems in road construction today is to develop means for keeping water out of the subgrade. It would seem that our present-day methods of drainage of roads do not always accomplish the purpose for which they were designed, and tests are being undertaken to discover means for enabling us to develop the bearing value of subgrades to the maximum possible extent. The experiments in this direction include experiments to determine the bearing value of soils containing different percentages of moisture, studies of capillarity in soils, and will include studies by means of models and full-sized road sections, to determine the best means for excluding water from the subgrade.

We are making an earnest effort to place road building on a much more scientific basis than exists at the present time. We should like to be able to gain enough knowledge so that having a given set of conditions of climate, subgrade and traffic, we shall be able to say with considerable certainty what constitutes the best type of road for those conditions. It would be very desirable if we were able to obtain information enabling us to say definitely that one type of road was comparable with another for carrying the same traffic. We believe that knowledge of this kind can only be had through tests of the character described in conjunction with a study of the behavior of roads under service conditions.

EFFICIENT DETOURS FOR HIGHWAY CONSTRUCTION

By L. H. Neilsen, Deputy State Highway Commissioner, Lansing, Mich.

In providing for the maintenance of the Michigan trunk line system it seems to have been the intention of the Legislature of 1919 to insure that the different routes in the state trunk line highway system should be maintained in the best possible condition, said Mr. Neilsen in an address at the recent Short Course of the University of Michigan. Although it was manifestly out of the question to arrange for the substantial improvement of the different portions of the system immediately, it has been found feasible to improve their condition very materially by making the best possible use of the local materials at hand. The public foots the bill and is certainly entitled to every effort on the part of those connected with road work to insure as comfortable and expeditious travel over every section of the trunk line highways as conditions will permit.

Suitable Detours

In the past I fear that all of us have been more or less negligent in taking pains to provide for traffic over and around sections which were unimproved. The Legislature of 1917 recognized this fact when it placed on the statute books Act No. 165. This law provides that the highway officials having jurisdiction shall have authority to close to public travel any road or bridge under construction, on condition that suitable barriers are erected at each end of the closed portions, and that suitable detours are provided. Notices must be posted showing the route to be followed and measures must be taken to place and keep these detours in reasonably safe and passable condition for travel. When the improvement under way shall have been completed and the section again opened to traffic, it further provides that these barriers and all signs and notices directing traffic to the detours shall be removed.

Michigan Practice

Many contracts have provided that where traffic could not be carried over the road during the progress of the work the contractor should bear the expense of providing and maintaining the detour. This practice has been discontinued as far as the work handled by the State is concerned. The maintenance of the detours is being taken care of as a part of the regular State trunk line maintenance program in each county. The results secured have fully justified this change in policy. In some instances detours are being maintained because the trunk line route as laid out is not as well improved as a road a short distance away, and in some cases the route is not opened and cut out as a public highway. Just as soon as sufficient work has been done on the trunk line route itself to make it a more economical road to maintain, the maintenance organization of the county is being asked to take care of the route actually laid out in place of the detours which were temporarily authorized. During the coming season it is planned to have resident engineers in charge of construction make weekly reports on detours, commenting on their condition. These reports will go to the district engineer and to the main office, and when neecssary the county maintenance organization will be requested to make improvement in the condition of the detours.

Plates are being prepared for a map of the State which will show the trunk line routes and their numbers. The stencils and instructions for their use, together with the maps showing the location of the trunk line routes and their numbers in each county will be sent out soon, and it is hoped to have the work of marking the system completed by the middle of May. The Highway Weather Bulletin, published twice a week by the East Lansing office of the U. S. Weather Bureau, has been a very great service to the traveling public during the past winter. It is proposed to continue this service through the summer, publishing, however, only one bulletin each week. It is planned to use this bulletin to show what sections of the different routes are under construction, and also to indicate the conditions of the detours and unimproved portions of the trunk lines, since these are the ones which will be first affected by rains.

Wherever arrangements are made to carry work through on roads which are unimproved it certainly must be expected that the contractor will render every service to the traveling public without allowing any of his employes to make a charge for helping the people through.

MOTOR TRUCKS AND OUR PAVEMENTS

By Monroe L. Patzig, Consulting Engineer, 418 Kraft Bldg., Des Moines, Ia.

Five years ago there were but few heavy trucks in general use for commercial purposes. Today there are more than 953,000 in the United States.

Paved streets no doubt have had a great deal to do with the fast growing demand for commercial cars, but the effect that this growth has had upon our pavements has been a serious one to those in charge of road and street

construction. Bituminous pavement construction that was perfectly satisfactory five years ago, may today be entirely unfit for present traffic.

Where traffic has been concentrated so as to follow single lines of travel, paths have become worn in concrete, brick, bitulithic and wood block pavements. Asphaltic concrete, sheet asphalt and bitulithic have shown tendencies to push or roll.

These conditions are not only true in Des Moines but evidences of the same conditions exist in all our large cities. In some of these towns where traffic has for a great many years been congested with heavy teaming over the hard surfaces of concrete, brick, stone, wood block and bitulithic pavements, the tendency to form ruts or ridges has been apparent. But with the increased use of heavy motor cars these same tendencies to rut the hard pavements and to cause rolling or shoving of the soft pavements, have been carried on to many streets that have never before shown such defects.

Conditions in Des Moines

That this is not caused merely by the general growth of the cities and the shifting of traffic to certain streets can be demonstrated by some streets in Des Moines and a thoughtful analysis of what takes place on the pavement when horse drawn or motor drawn vehicles pass over it.

As examples of brick paving may be named Beaver Ave. and South 9th Street laid in 1910. These were narrow pavements upon which hauling was confined generally to a single line of traffic. On south east Sixth Street, East 14th Street, and West Grand Ave. can be seen results of traffic on concrete pavements. Ingersoll Ave., Mulberry St., 10th St., Clark St., University Ave., and Third Street show results of modern traffic on Bitulithic Pavement. All of the foregoing represent the effects on hard surfaces and in these cases the pavements show a disintegration caused by the pounding effect of the traffic.

On West Court Ave., Mulberry St., West Grand Ave., and West Ninth Street will be seen examples of sheet asphalt pavements that have pushed or rolled under tractive force of motor vehicles. It is on this type of pavement that our first attentions were forcefully drawn. At no time before the heavy motor truck age were these difficulties experienced. The writer's attention was first called to the effects shown upon West Court Avenue between First Street and Fifth Street.

This pavement was carefully constructed under the most rigid inspection known to Des Moines. It was considered an ideal piece of work when completed; within 2 years there had developed many exasperating waves and depressions and repairs were necessarily made. Upon making these repairs it was determined that the paving material had bunched up and actually moved along over the base. The movement, therefore, had actually polished the concrete foundation.

While the causes for this may partly be due to the construction which was specified for this piece of work, we are also aware of the fact that the changed traffic had much to do with it.

At the same time the public was irritated by the conditions on this street, similar defects appeared on Mulberry St. between 7th and 9th Streets, although this pavement was then about 5 years old and had been in perfect shape until that time. Other streets showed movement of the wearing surface to a marked degree at about the same time, but all of them along routes taken by the heaviest motor drawn vehicles. A careful consideration of this matter has also revealed the same circumstances and results in practically all of the larger cities.

Impact

Now the cause seems very simple and clear. Where our heaviest loads rarely exceeded 3 or 4 tons, at the present time our pavements carry loads up to 12 and 15 tons. The load is considerably increased but the action upon the pavement is a great many times more severe due to the rebounding action of the springs, which causes an impact or hammerlike blow on the pavement. The springs cause a succession of these blows upon hitting a depression or other obstacle in the roadway. The speed of the car also intensifies these blows, for it has been demonstrated by authorities on this subject that the impact is greater with increased speeds.

For the sake of showing this more clearly let us assume two large balls of equal size, one weighing one ton and the other weighing 4 tons. The small one will represent the weight upon one wheel of a heavily laden coal wagon while the other will represent the load on one wheel of a 16-ton truck loaded to its capacity. Imagine these two balls rolling over a smooth surface until we come to a depression. Here you will notice the balls to drop down into the depression if deep enough and thereby give a hammer-like blow on the bottom. If the depression is slight the impact will be thrust upon the opposite side with a tendency to enlarge the size of it. In the case of both balls traveling at the same speed you will readily see that the impact of the larger is about four times that of the smaller. If the larger ball travels faster than the small one the difference in impact will be still greater. Now if the ball exerts its pressure on the surface through the action of springs, I believe you can see how this impact will set up a series of these blows which are directed along the line of travel. Now if you will think of this surface which we have been running over, as made of some soft material as asphalt or some other yielding material, you can readily understand how these impacts have a tendency to make depressions or to increase them in size. This is exactly what takes place on our asphalt pavements and as described has occurred on certain streets.

This is a very serious matter and it has made an investigation necessary to determine the cause before a reasonable remedy could be prescribed.

By again considering the soft surface, one can readily see how the surface will resist these impacts if made of tougher and harder materials. I say tougher because one may make the surface so hard that it becomes brittle and will not resist the impact. Upon making it harder and tougher it will not be dented so easily.

In a pavement too soft to resist the strain, I believe one can also see what happens when brakes are suddenly applied or the turning power is suddenly applied to the wheels. The tendency is to push the surface either forward or back. By examining surfaces at certain street intersections one will see that this has actually occurred.

Constructing Bituminous Pavements for Truck Traffic

It is a fact that bituminous pavements, and especially those using the smaller sizes of mineral aggregates, are ideal for paving purposes for the reason that they can be made hard and tough or brittle.

Since the cause has now been determined, it is a comparatively simple matter to construct bituminous pavements so as to resist the traffic we now have. Many streets have since been laid in Des Moines in accordance with this theory and are proving entirely successful, whereas if they had been laid in the same manner ten years ago the practice would have been condemned.

To those who are not familiar with the construction and proportions of bituminous pavements the writer hopes to drive away the fear that may have existed upon seeing the bad effects during the past five years. Where competent supervision of such construction exists, no better type of pavement can be had. The entire situation is now well under control, and better results can be secured with bituminous pavements than with many other materials.

The entire situation is one that could not have been forseen. Trucks are being used more and more each day and more disastrous results can be looked for on brittle road surfaces. As to bituminous surface construction under the supervision of competent persons, good results will be obtained.

Preventive Measures

Where it was formerly desirable to use as the proper consistency for asphaltic cements 65 to 75 penetration or higher, in order to prevent cracking of the surface, penetrations of 50 to 65 are now found successful to combat the heavy truck traffic of today.

It is also necessary to guard more closely the grading of the mineral aggregate so as to prevent the use of mixtures that will be likely to creep. A mixture containing too large a percentage of dust or fine material will be likely to shove or creep, and likewise too high a per cent. of larger aggregate will not have sufficient stability to resist the tendency to push it out of place.

It has also been found necessary to use a mixture similar to the wearing surface of a sheet asphalt pavement to cover the coarser asphaltic concrete or bitulithic pavements. Without this covering winter traffic has shown itself to be severe on this type of construction, and the mixture breaks up or disintegrates very rapidly. To prevent this unraveling from continuing it is necessary to cover this surface with another seal coat or mixture as just described. As long as the coarse aggregate is exposed to the weather and traffic it is certain to occur again if the traffic conditions are not greatly decreased.

THE IMPORTANCE OF ZONING A MUNICIPALITY

By Louis Bartlett, Mayor of Berkeley, Cal.

We are all familiar with residence parks, where the restrictions on the improvements are included in the deeds to the property. They have been tremendous successes. And today tens of millions of dollars in assessed valuations owe their existence to them. The zoning of cities brings about throughout the city the advantages gained in these residential parks, and it brings to the poor and people in moderate circumstances the advantages which have heretofore been reserved almost exclusively for the rich. It is essentially democratic, for it prevents the hog from imposing upon his more timid or poorer neighbor, who cannot afford to protect himself by an additional investment, said Mayor Bartlett in addressing the 21st annual convention of the League of California Municipalities.

Right to Establish Zones

Zone laws are passed by virtue of the police power of the State. It is that power which allows a State to interfere with private rights in the public interest for the protection of the morals, health and safety, and even for the convenience of the public. The legal status of zoning has not been defined as yet by the courts, but some very interesting cases from the highest courts of the land are the forerunners of others which, in my judgment, will ultimately establish everywhere the right of cities and of the State to establish zones. The restrictions thus far made divide cities into zones according to the height of the buildings and the area to be covered by each, and the use to which the property may be put.

Height Limits

It was determined rather early that height limits were within the police power. For example, in Boston it was decided that the municipal authorities could divide the city into different districts, each of which should obtain a different height limit. The court held that this was a reasonable measure of protection for the public health and safety, and alluded particularly to fire protection and to the health of dwellers in tall apartments and residences.

In California we have a State Tenement House Law based upon the Housing Code adopted in Berkeley some years ago, prepared under the general supervision of Mr. Frank V. Cornish, our city attorney. This Housing Code provides height limits, and what portion of the area of the lot may be covered by buildings. The restrictions of the use to which land may be put has not been so thoroughly tested in the courts as the height and area limitations have been.

Los Angeles the Pioneer

Los Angeles was, I think, the first city in the country to experiment with a zone law of this character. It was passed in 1909, and provided for certain business districts defined in the ordinance, and left the rest of the city for residences. The act was passed after an intensive study of the existing conditions in the city, and in the light of later laws is rather crude. Nevertheless it was a distinct step forward and has been of great value to the country at large, because it has gone through the courts of California and the United States Supreme Court, and we have learned some things which a zone law can do without violating the state and national constitutions. For example, it prohibited laundries except in designated places, and went so far as to abate a brick kiln which had been in existence for many years, even before the location was annexed to the city of Los Angeles. The Supreme Court of the United States went so far as to say that the character of the neighborhood of the brick kiln having changed into residential one, it was within the police power of the city to suppress it by a zone law in the public interest, as it interfered with the social use to which the surrounding property was being put.

Tendency of Zone Laws

The tendency of later zone laws has been to make more minute classifications than the early Los Angeles ordinance. At the present time there is pending before the city council of Berkeley a zone law which divides the

city into three main classifications—residence, business and industry. Industry is subdivided into the noxious, such as soap works, oil works, incinerators, abbatoirs, etc., that are put off by themselves. And then other factories. Business is similarly divided into the high-class retail district that suffers from the close proximity of garages, etc.; and then the wider business district that includes garages and similar institutions. All classes of residences, whether they be apartments or flats, boarding houses and hotels, are permitted in the residence district. And there is another classification for public and semi-public buildings, such as schools, churches, hospitals, etc.

The ordinance legalizes the existing use of every piece of property so as to avoid hardships, and it permits residences in the other ones, though it does not permit other uses in the strictly residential ones. As you see, this ordinance is not a very rigid one. Far less rigid than would be imposed if a new city were to be laid out. Too many vested interests are at stake, and too violent a change would be not only difficult to accomplish, but might work injury to a considerable number of people. The purpose of the zone ordinance is to prevent that very thing, and wherever established it does do that if wisely drafted. We have now the experience of a good many years in residence districts, and can say with finality that they are not only beautiful and attractive, but sound from an economical sense. Property values are maintained and the assessment roll gradually rises as the residence districts become more built up and attractive. The great loss that comes from the indiscriminate use of property for various purposes was easily visualized when one block in New York lost about seven million dollars of assessed valuation because of a change in use.

Berkeley Zone Law

We have a zone law on the Berkeley statutes at the present time which differs in operation from the one of which I have spoken. It consists of a series of definitions of zones. One permits single family residences only. Another flats and single family residences. Third, flats, multiple houses and single family residences. Fourth, apartment houses, boarding houses, fraternity houses, etc., without stores underneath. There are a number of different classifications, but these are illustrative. If the residents of a part of town wish to put themselves into one of these classes they petition the council, and then the neighbors are notified, and after hearing the area may be classified by the council into one of these zones. At the present time about five per cent. of the city of Berkeley is so classified—largely into the single family residence zones. This zone corresponds roughly to the restrictions in private residence parks, although it is not nearly as stringent, as it does not involve set-back lines, prohibition against the ownership by negroes and Orientals, etc. So far as I know the legality of this particular kind of zone has never been up before the courts, but in my judgment the courts will sustain it, for the only question involved is, Is this a reasonable exercise of the police power of the State? Does it, in other words, promote the public health, welfare, safety or convenience? Inasmuch as tens of thousands of people have answered that question for themselves in the affirmative by buying into restricted districts, and millions of dollars of property values have been built up in this way, I think it extremely unlikely that the courts will hold this an unreasonable exercise of the police power.

Education Necessary

There is a very practical problem in the zoning of municipalities, and that is the problem of educating people so that they can understand its advantages. The first thing to do is to prepare a use map of the city, showing the use to which every piece of property is put. Then neighborhood meetings should be called and those in the neighborhood asked what restrictions, if any, they want for their property. When this has been done throughout the city there is a fair chance that the law may be adopted without great opposition. And it is to be noted that the law that will be first adopted will not be perfect. It will develop injustices and inequalities which may be brought sharply to the attention of the city authorities. But if the law has been prepared with care there will be far fewer of these than if the city be not zoned at all. For without zoning it is in the power of any private individual to create an unjust situation on all sides of his property, and many owners are doing that every day. It must be borne in mind, too, that cities grow, and that we should not regard a zone law as something which cannot be amended. We should be prepared to expect growth and to guide it wisely in the changing of the lines in the zones.

COMPUTATION OF BACKWATER CURVES IN SEWER DESIGN

By C. D. Hill, Engineer, Board of Local Improvements, City Hall, Chicago, Ill.

In designing large sewers with free discharge, and where it may be reasonably expected that the surface of the water near the mouth o the sewer at flood will be approximately at mid-depth of the sewer, it is of great importance to be able to determine the rise of the surface of the water upstream, commonly called the backwater curve. Under these conditions the outfall section of the sewer has much greater capacity than the same sized sewer at a greater distance from the outfall. It is possible to economize on the size of the sewer, and particularly where the ground is low near the outfall it is possible to diminish the vertical diameter, thereby obtaining more cover over the sewer without in any way affecting the capacity of the sewer.

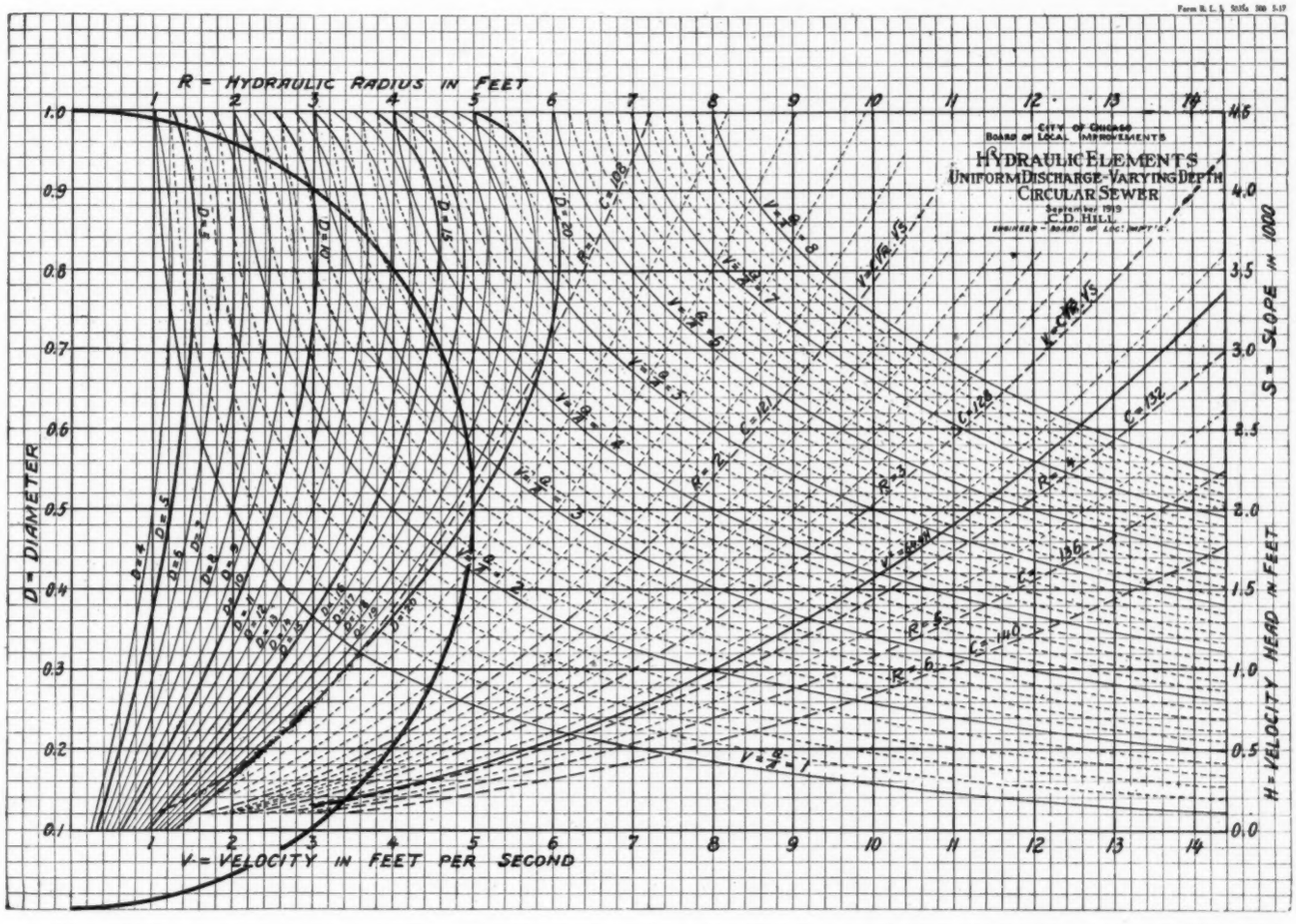
Uses of Backwater Curve

The backwater curve is useful in the design of sewers exceeding 6 ft. in diameter when, on account of the low elevation of the land to be drained, it is necessary to build the sewer at a minimum gradient. The velocity of flow in a sewer is determined by the slope of the surface of the water and not by the slope of the bottom of the sewer. Under certain conditions it can be shown by the backwater curve that an adequate velocity will be maintained, while too low a velocity would be indicated by the slope of the sewer. With sewers less than 6 ft. in diameter the use of the backwater curve is of little value, for the reason that the rise of the water is so rapid and the distance from the outfall to the full section is too short.

Another important use of the backwater curve is to obtain the approximate water level at various localities in

the sewer district at times of flood, when an assumed run-off occurs, and to judge of the effect of the back-water on basements of buildings.

In one design it was proposed to carry 275 second-feet through a 10 ft. relief sewer with a gradient of 0.03 per hundred. The sewer was to have a free discharge into the river and was to be over a mile in length. On the assumption that the 10 ft. sewer would flow full at the upper end, it was found that basements drained by a lateral sewer would be flooded. However, computations


R = HYDRAULIC RADIUS IN FEET
D = DIAMETER
V = VELOCITY IN FEET PER SECOND
S = SLOPE IN 1000
H = VELOCITY HEAD IN FEET
CITY OF CHICAGO
BOARD OF LOCAL IMPROVEMENTS
HYDRAULIC ELEMENTS
UNIFORM DISCHARGE-VARYING DEPTH
CIRCULAR SEWER
September 1919
C. D. HILL
ENGINEER - BOARD OF LOC. IMPR'TS

CURVES SHOWING HYDRAULIC ELEMENTS FOR CIRCULAR SEWER FOR UNIFORM DISCHARGE AND VARYING DEPTHS.

showed that under the conditions the depth of water at the upper end would be less than 7 ft. and that the basements would be drained.

Such computations have been made by engineers, but the writer is not aware of any published description of the method employed, although the principles involved are discussed and the method indicated in Merriman's "Treatise on Hydraulics."

Assumptions and Computations

The usual method involves a great many tedious calculations. The assumption is made that a constant volume of water is flowing through the sewer, that the depth of water near the outfall is a definite amount determined by local conditions, that at an unknown distance from this point the depth of water is a definite amount slightly greater, the problem being to compute the distance. It is necessary to compute the wetted area at successive cross-sections of the sewer corresponding to assumed depths of water, to compute the hydraulic radius, the velocity, the velocity head and the corresponding slope at such cross-sections at each of which a definite depth is assumed, and from these elements to compute the distances between the successive cross-sections.

The distance between two cross-sections multiplied by the slope of the sewer, plus the difference between the depths of water at the two cross-sections, equals the difference between the elevations of the surface of the water at the two cross-sections. This difference must equal the head necessary to overcome the frictional losses due to the average velocity between the stations; that is, the distance between the cross-sections multiplied by the hydraulic slope corresponding to the velocity and the hydraulic radius, plus the difference between the velocity heads of the two cross-sections. This may be expressed:

$$L S_1 + (d_2 - d_1) = L S + (H_1 - H_2)$$

$$L = \frac{(d_2 - d_1) - (H_1 - H_2)}{S - S_1} = \frac{d' - H'}{S'}$$

The elevation of the bottom of the sewer being known and the elevation of the surface of the water at the first cross-section being assumed, the elevation of the surface of the water and the location of the successive cross-sections can be computed.

The computations are based on the fundamental as-

sumption that the volume of flow is constant and that there is no substantial contribution to the flow between cross-sections. At points where the volume is increased by contributions from lateral sewers it is necessary to make allowance for loss of head due to change of velocity. At curves and at changes of diameter loss of head should be estimated.

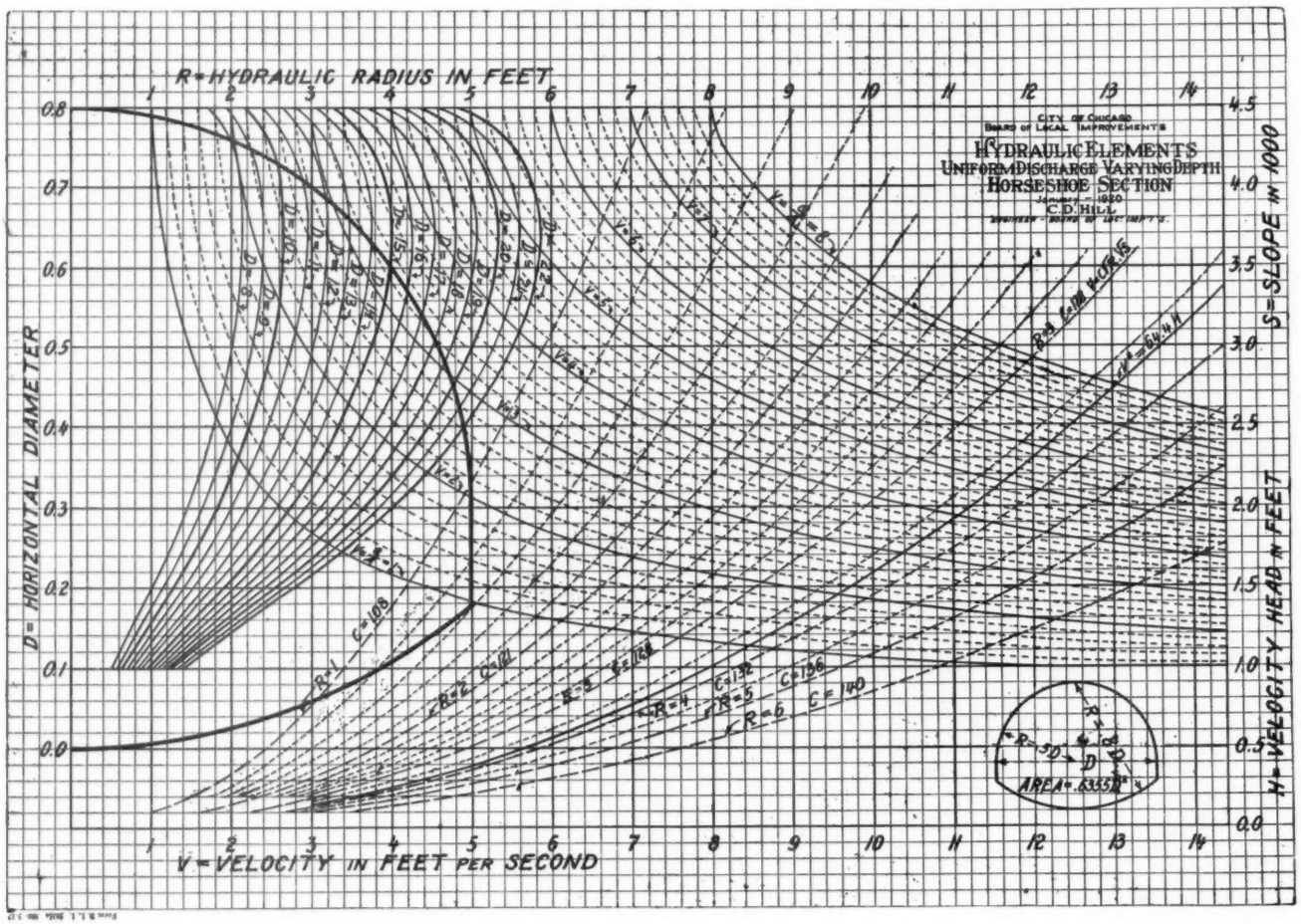
Computation Sheet

A great deal of the tediousness of the computations can be avoided by the use of the computation sheets and the diagram which is published herewith.

At the top of the computation sheet should be recorded the diameter of the sewer in feet, the assumed volume of flow, the area of the full cross-section of the sewer, the velocity of the assumed volume flowing through the full bore of the sewer, and the gradient or slope of the sewer. In the first column enter the assumed depth in decimal parts of the diameter for each cross-section; in the second column enter the same depth in feet; in the third column enter the difference in feet between the depths at successive cross-sections; in the fourth column enter the hydraulic radius corresponding to the depth at each cross-section; in the eighth column enter the velocity, equal to the volume divided by the wetted area, for each cross-section; in the fifth column enter the corresponding velocity head; in the sixth column enter the difference between the velocity heads at successive cross-sections; in the seventh column enter the difference between the quantities in the third and in the sixth columns; in the ninth column enter the hydraulic slope corresponding to the velocity and the hydraulic radius of each cross-section; in the tenth column enter the difference between the hydraulic slope and the slope or gradient of the sewer; in the eleventh column enter the computed distance between successive cross-sections; in the twelfth column enter the elevation of the bottom of the sewer at each cross-section, and in the thirteenth column enter the corresponding elevation of the surface of the water.

Using the Diagrams.

By means of the diagram it is possible to read directly



CURVES SHOWING HYDRAULIC ELEMENTS FOR HORSESHOE SEWER FOR UNIFORM DISCHARGE AND VARYING DEPTH.

On the scale at the left margin of the diagram is read the assumed depth of water expressed in decimal parts of the diameter. On the scale at the top of the diagram is read the hydraulic radius of sewers of various diameters at any assumed depth of water which is indicated by the intersection of the horizontal line corresponding to the diameter.

The curves $V = \frac{Q}{A} = 2$, etc., show the velocities, read

at the bottom of the diagram, of a constant volume flowing at various depths corresponding to the velocity of the same volume flowing through the full bore of the sewer.

The intersection of the curve $V^2 = 64.4\ H$ with the velocity ordinate shows at the right margin of the diagram the velocity head corresponding to the velocity.

The curves R=2, C=121, $V = C\sqrt{R}\sqrt{S}$, etc.; show the relationship between the velocity, hydraulic radius and slope; the first two being indicated by the velocity ordinate and the curve, the corresponding slope can be read at the right margin of the diagram. The value of C corresponding to each value of R is obtained by Kutter's formula with a value of n = .014.

It is believed that the errors due to the inaccuracies of the diagram are much less than the errors due to the assumptions in regard to the water flowing through sewers.

To use the diagram, enter at the left margin of the diagram at the elevation corresponding to the assumed depth of water at the cross-section under consideration.

Note, and record on the computation sheet, the assumed depth in feet and in decimal parts of the diameter. Trace horizontally to the right to the intersection with the curve

Backwater Curve Computation Sheet
Uniform Discharge - Varying Depth

D=			Q=		A=		V=$\frac{Q}{A}$=		S_1=		L=$\frac{d_1-H_1}{S_1}$
1	2	3	4	5	6	7	8	9	10	11	12	13
Depth			R	H	H_1	d_1-H_1	V	S	S_1	L	Elevation	
D	d	d_1									Sewer	W.L

corresponding to the diameter of the sewer, and read at the top of the diagram, and record the hydraulic radius. Continue to the right to the intersection with a curve corresponding to the velocity when the sewer is full, trace vertically downwards and at the bottom of the diagram, read and record the velocity. Where the velocity ordinate intersects the curve $V^2 = 64.4\ H$ trace horizontally to the right margin of the diagram, read and record the corresponding velocity head. Where the velocity ordinate intersects the curve corresponding to the hydraulic radius, trace horizontally to the right of the diagram, read and record the corresponding slope.

Repeat these operations for the successive cross-sections. Compute d', the difference between the depths at two adjacent cross-sections. Compute H', the difference between the velocity heads at the same cross-sections. Compute S', the difference between the slope S, as read on the diagram and S_1, the slope of the sewer. Compute L, the distance between the cross-sections by dividing d' — H' by S'.

DESIGNING STREET PAVEMENTS FOR SMALL MINNESOTA CITIES

By George M. Shepard, Associate wtih Louis P. Wolff, Consulting Engineer, St. Paul, Minn.

As a general rule, in cities of this class (less than 10,000 inhabitants), where no paving has been done and no fixed policy determined, bids are called for upon several types of pavement, and the final selection is made upon a basis of cost and engineering advice as to adaptability for existing conditions. It is therefore common practice for engineers in this part of the country to prepare specifications covering various types of pavements rather than to restrict the bids to a single type.

I will give a few notes covering pavements actually constructed during 1919, under specifications drawn by this office, or contracted for during the present year, up to the present time. Out of a total of 575,000 sq. yds. of pavements contracted for between March 20, 1919, and February 17, 1920, covering 10 cities of this class, 255,000 sq. yds. were reinforced concrete, 45,000 sq. yds. were asphaltic concrete, Class A, and 275,000 sq. yds. were asphaltic concrete, Class B.

The matter of laying water and sewer house connections to vacant lots and the replacing of old galvanized water service pipes with lead, together with the proper protection for steam heating mains, gate valves, etc., is work of a routine nature, which must always precede paving and need not be touched upon in detail here.

Width of Roadway

The first matter of importance for the engineer to determine is the width of the roadway on the streets. For a main street, 100 ft. in width between property lines, 15-ft. walks, with a 70-ft. roadway, works out very well, while for an 80-ft. street, 12-ft. walks and 56-ft. roadways give suitable proportions. Under conditions generally found in cities of this class the walk width on each side of a business street should be approximately 15 per cent. of the entire width of the street.

For residence streets a minimum width of paving of 30 ft. has been adopted, with 34 to 40 ft. for the arterial streets connecting with state highways in the country. The paved roadways of semi-business streets may vary between the above limits. Where extremely wide streets occur in the residence districts, double roadways are frequently used, with a parkway at the center.

Pavement Crowns and Gutter Slopes

The pavement crowns vary with the type of pavement and the grade of the street. For concrete pavements the crowns vary from 0.5 ft. for a 30-ft. width to 0.75 ft. for a 70-ft. width. For asphaltic concrete pavements the crown varies from 0.55 ft. for a 30-ft. width to 0.85 ft. for a 70-ft. width. For steep grades the crown is somewhat less than the figures just given.

Experience has shown that where the gutter slope is less than 0.8 ft. per block of 300 ft. the drainage is unsatisfactory, consequently with flat grades the normal curb exposure of 6 ins. is varied to obtain the necessary fall.

In cases where trunk roads of the state highway system pass through these cities, the plans and specifications are submitted to the State Highway Commission for approval, so that upon passage of the proposed Babcock Amendment cities may arrange with the various counties to receive a portion of the refundment of State and Federal Aid.

Drainage

The matter of sub-drainage is as important with city pavements as with country roads, and in some places it

is common practice to lay tile drains adjacent to the curbs. However, in cities where both storm and sanitary sewers have been previously laid, there is a question as to the advisability of incurring additional expense for tile drainage, as the existing sewers will be quite effective in draining the soil, especially after the pavements are completed and proper surface drainage has been provided.

In a strictly business district the entire area is covered with buildings, pavements or sidewalks, leaving very little access to the tile for surface water, and in a residence district with properly sloped boulevards, surface water quickly finds its way to the pavement, gutters, and thence into the storm sewers.

There is also the additional subsoil drainage obtained by sewer trenches and house connection ditches, as nearly all engineers are familiar with the lowering of ground water level which takes place after the construction of a sewerage system, most of this lowering being due to indirect entrance to the sewer system through pipe joints. Although there are cases in heavy soil where tile drainage for city pavements is beneficial, in many instances it is an unnecessary expenditure.

Grading

The grading includes the making of fills, the removal of all material between curb lines, the preparation and rolling of the sub-grade ready for the laying of the pavement proper, together with the removal of all crossings, gutters and culverts.

Excavation is paid for on a cubic yard basis, the price bid including all of the above items. Excess material not placed behind the curbs or used for filling boulevards is hauled away, overhaul being paid for at the rate of 2 cts. per cu. yd. per 100 ft., over a free haul of 1,000 ft.

The sub-grade is brought to a firm, unyielding surface by rolling with a 10-ton roller. By using a roller of this weight, soft spots in the streets, due to new and old ditches, are compacted and danger from future settlement avoided. Where fills are made all vegetable or perishable matter is removed from the top surface, the fill deposited in layers not more than 12 ins. in thickness, and the surface passed over at least twice with the roller.

Curbs

Alternate bids are generally received upon two or more types of curbs. Type A is a standard curb, 6 ins. wide and 17 ins. deep. Type B is a special curb generally used in the business section and on filled streets. It is 6 ins. thick at the top, with a 1:12 batter on the front face, and a depth varying with conditions. Type C curb is a 6-in. integral curb which is used only in connection with reinforced concrete pavements. Type D curb is a combined curb and gutter, consisting of a 6-in. curb with a 2-ft. gutter apron. This latter type is used more particularly with pavements having an asphaltic wearing surface, and its use is confined principally to residence districts.

The mixture specified for curbs is a 1:2½:4½ mix, using approved crushed rock or screened gravel for coarse aggregate, or a suitable mixture of pit-run gravel, based upon the proportions given in the following table:

PROPORTIONS FOR PIT-RUN GRAVEL

Ratio Pebbles Retained on No. 8 to Pit-run	Use Sacks Cement	Use Cu. Ft. Pit-run Gravel	Use Sacks Cement	Use Cu. Ft. Pit-run Gravel	Use Cu. Ft. Screened Gravel
.66	1	5.00	1	5.00	0.00
.60	1	4.65	1	4.65	0.44
.55	1	4.39	1	4.39	0.76
.50	1	4.16	1	4.16	1.05
.45	1	3.94	1	3.94	1.33
.40	1	3.75	1	3.75	1.56
.35	1	3.57	1	3.57	1.79
.30	1	3.41	1	3.41	1.99
.25	1	3.27	1	3.27	2.16

After the concrete has been poured and has stiffened sufficiently, the forms are removed and the top surface and exposed face troweled to a smooth and uniform surface. The surface of the gutter for the Type D curb is finished with a 1:2 Portland cement mortar ½ in. in thickness, which is put on immediately after the concrete has been placed.

Expansion joints ⅜ in. wide, extending through the entire thickness of the curb, are placed in the curbs in line with the transverse expansion joints in the concrete pavements and at intervals of about 30 ft. for other pavements. Radius curbs varying from 2 ft. radii at alley returns on business streets to 15 ft. or 20 ft. radii at residence street intersections, are used.

Reinforced Concrete Pavements

Reinforced concrete pavements both 6 and 7 ins. in thickness have been constructed, the thickness depending upon the soil and traffic conditions. The cement used is required to meet the latest specifications and tests for Portland cement adopted by the American Society for Testing Materials. The contractor provides for inspection at the mills by a reliable testing bureau, and includes the cost in his bid, this bureau furnishing certified copies of the mill tests of each shipment to the engineer.

The fine aggregate is clean, hard sand, free from clay, loam or other deleterious matter, and when tested by laboratory screens must meet the following requirements:

Passing a ¼-in. screen.....100 per cent.
Passing a 20-mesh and retained on the 50-mesh sieve .....30 to 65 per cent.
Total passing 50-mesh sieve, not more than..20 per cent.
Total passing 100-mesh sieve, not more than. 5 per cent.

Alternate bids were formerly received, based upon using crushed granite, trap rock or quartzite or screened gravel, but recently the bids have covered the following three classes of coarse aggregate: First, Class A rock, consisting of the best quality of crushed granite, trap rock or quartzite, having a French co-efficient of wear of not less than 8 and a toughness of not less than 8; second, Class B rock, consisting of crushed rock, having a French co-efficient of wear of not less than 5 and a toughness of not less than 5, and third, consisting of clean, screened gravel.

The inclusion of the Class B rock was due to the fact that on account of the scarcity of the harder materials, the paving construction would have been cut down considerably had not more available and somewhat softer rocks been allowed.

The concrete for reinforced concrete pavements is a 1:2:3½ mix containing not less than 1.7 bbls. of cement per cu. yd. of concrete for hand finish, or a 1:2:4 mix, containing not less than 1.6 bbls. of cement for machine finish.

It is required that each batch remain in the mixer at least 1 minute after all materials have been placed in the drum, and shall have not less than 12 nor more than 18 full turns of the mixing drum.

Although machine-finishing is covered by several clauses in our specifications, machines have not as yet been developed for suitable finishing of pavements over 24 or 26 ft. in width, and consequently are not as yet in use for finishing city pavements, although they are very commonly employed on country highways.

In hand-finishing, the surface of the concrete is struck off by means of a strike board or is brought to the proper surface by means of grade-pins and floats manipulated by wooden handles. Special care is taken to consolidate the concrete along expansion joints. After the surface is brought to proper grade it is rolled with a split roller approximately 10 ins. in diameter and 6 ft. long, weighing about 75 lbs. At expansion joints the split is opened and the roller operated so that the split will straddle the joint. This operation is to be repeated at intervals of 15 to 20 minutes until no free water is squeezed from the surface. Immediately after the rolling the surface of the pavement is finishd with belts, the surface being gone over twice.

The space along the curb which cannot be finished with a belt is finished with a wooden float. A separate float is used to finish the surface along expansion joints and to better compact the concrete at this place a finish tool is used to finish the edges of the joints to a ¼-in. radius.

After the concrete is sufficiently hardened, the surface of the concrete is kept continuously moistened by sprinkling, and under most favorable conditions the pavement is not opened to traffic for at least 14 days after its completion. Concrete is not mixed or deposited when the temperature is below freezing.

Longitudinal expansion joints are constructed along each curb and also at intermediate points for streets over 55 to 60 ft. in width. Transverse expansion joints are constructed across the pavements at intervals generally not less than 40 ft., and at street intersections running diagonally from the radius curbs towards the center of the street.

The diagonal joints at the intersections are used to eliminate the unsightly cracks which generally radiate from man-hole covers at the center of streets where joints and reinforcement have not been used.

All joints are formed during construction by inserting and leaving in place a joint filler, ⅜ or ½ in. in thickness, extending through the entire thickness of the paving.

No metal protection at the joints is used, but especial care is taken to secure a dense concrete and a true surface next to the joint. The principal objection to joints is the slight impact at regular intervals felt when riding over a pavement with expansion joints, this usually being due, not to the joint material, but to the improper finishing of the surface on either side.

The concrete pavements are reinforced with round, deformed bars, of structural or intermediate grade steel, the total weight of steel being approximately 3 lbs. per square yard. Each separate block between expansion joints is generally reinforced along all edges, with a ⅝-in. round bar laid about 6 ins. from the edge, and through the interior with ½-in. round bars. The bars are placed so that the center shall be 2 ins. below the top of the finished pavement.

Concrete Foundations for Pavements with Wearing Surface

The tendency in Minnesota has been toward the construction of a rigid base for all pavements with wearing surface. The rigid base has the advantage of bridging over any soft spots in the sub-grade, and is suitable to the extreme climatic changes which occur in this region.

In our work in cities of this class a Portland cement concrete base 5 or 6 ins. thick has been specified, alternate bids being received upon the two thicknesses. Crushed rock or screened gravel is used for the coarse aggregate of the base, a 1:2½:4 mix being used for hand-finished and a 1:2½:4½ for machine-finished work.

In order to insure the proper compactness of the concrete in the base, rolling similar to that employed for concrete pavements is required, after which the surface must be gone over with a spiked roller or tamper, so as to provide a proper bond for the wearing surface.

Asphaltic Concrete, Class A

This pavement consists of an asphaltic concrete wearing surface 2 ins. thick, laid upon a 5 or 6-in. concrete base. Natural lake fluxed asphalt or oil asphalt meeting the specified requirements may be used for the bituminous cement. The penetration required for the fluxed natural lake asphalt or the oil asphalt at 25 degrees C. (77 degrees F.) is 55 to 60 for 100 gr. wgt. 5 sec.

The coarse aggregate consists of best quality crushed granite, trap-rock or quartzite, having a French co-efficient of not less than 8 and a toughness of not less than 8. When tested by laboratory screens it must meet the following requirements:

Passing ½-in. screen, not less than..... 95 per cent.
Retained on ¼-in. screen, not less than..... 37 per cent.
Retained on 10-mesh sieve, not less than....100 per cent.

The fine aggregate is composed of sound, durable stone particles or of clean, moderately sharp sand, properly graded. When tested by means of laboratory screens the fine aggregate shall meet the following requirements:

Passing a ¼-in. screen.....100 per cent.
Passing a ⅛-in. screen..... 95 per cent.
Retained on 200-mesh sieve, not less than... 95 per cent.

The mineral filler consists of Portland cement and limestone or dolomite dust. Not less than one-half of the mineral filler is Portland cement and not less than 47 lbs. of Portland cement is used in each 1,000-lb. batch of bituminous concrete.

The total mineral aggregate must consist of a uniform mixture of the above ingredients, the grading and proportionate amounts of each being such as to give the following proportions:

	Allowable Limits	Desired
Passing 200 mesh	10% -12%	11%
Passing 80 mesh	10½%-12½%	11½%
Passing 40 mesh	10% -14%	12%
Passing 20 mesh	11½%-15½%	13½%
Passing 8 mesh	13% -17%	15%
Passing ¼ in. screen.....	13% -19%	16%
Passing ½ in. screen.....	18% -24%	21%
		100%

After being thoroughly heated to the temperature directed, the bituminous material and the mineral aggregate

is measured and mixed so that the resulting mixture contains from 70 to 90 lbs. of the bituminous cement to 1,000 lbs. of mineral aggregate. When delivered, the bituminous concrete must have a temperature of not less than 225 degrees F.

The mixture is dumped far enough in advance of its final position to insure the load being turned. When rolled and thoroughly compacted it must have a thickness at no place of less than 2 ins. and a weight per square yard of not less than 220 lbs. for each batch, and must be free from surface depressions or irregularities.

Upon completion of rolling, a thin coat of Portland cement is applied with a broom, using 1 bbl. of cement to 1,200 sq. yds. of pavement.

Asphaltic Concrete, Class B

As with Class A, this type provides for a 2-in. wearing surface of asphaltic concrete, laid upon a 5 or 6-in. concrete base. The specifications and requirements for bituminous cement are the same as described for Class A.

The broken stone is of the best quality of crushed granite, trap-rock or quartzite, having a co-efficient of wear of not less than 8 and a toughness of not less than 8. The coarse aggregate must be the product of the crusher, which, when tested by means of laboratory screens, must meet the following requirements:

Passing a 1-in. screen, not less than..... 95 per cent.
Total passing a ¾-in. screen.....35 to 65 per cent.
Retained on ¼-in. screen, not less than..... 95 per cent.

The fine aggregate is composed of sound, durable stone particles or a clean, moderately sharp sand, and, when tested by means of laboratory screens, must meet the following requirements:

Passing ¼-in. screen .....100 per cent.
Total passing ⅛-in. screen..... 95 per cent.
Total passing 40-mesh sieve.....30 to 70 per cent.
Retained on 200-mesh sieve, not less than... 95 per cent.

The mineral filler must consist of limestone dust, dolomite dust or Portland cement. The total mineral aggregate must consist of such a mixture of the coarse and fine aggregate that, when tested by means of laboratory screen, it will conform as closely as possible by weight to the desired proportions as given in the following table:

	Allowable Limits	Desired
Passing 200 mesh	7% - 9%	8%
Passing 80 mesh	6% - 8%	7%
Passing 40 mesh	6% - 8%	7%
Passing 20 mesh	6% - 8%	7%
Passing 8 mesh	6½% - 9½%	8%
Passing ¼ in. screen.....	6½% - 9½%	8%
Passing ½ in. screen.....	14% -20%	17%
Passing 1¼ in. screen.....	34% -42%	38%
		100%

From 70 to 90 lbs. of bituminous cement for each 1,000-lb. batch of mineral aggregate is required. This mixture is spread and rolled as previously described, so that after rolling it has a thickness at no place of less than 2 ins., and a weight of at least 240 lbs. per square yard for each batch.

As soon as possible after the rolling of the mixture has been completed, and while the surface is still warm and clean, a seal coat of asphaltic cement is spread over the surface, sufficient in amount to fill the surface voids. Over this seal coat is spread a dressing of clean stone chips, this covering to be broomed and rolled into the surface, a small surplus being left to wear away by traffic.

Creosote Block

Previous to the war a number of the smaller cities had laid several blocks of creosoted wood block pavement in the business districts, where subject to the heaviest traffic, and there has generally been a tendency to consider this type when bids have been received since the war. This pavement, as specified, consists of a creosote wood block laid upon a pitch filler on a concrete base, alternate bids being called for, using 3 and 3½-in. blocks. On account of the high prices bid for this type of pavement, however, very little has been constructed during the past year outside of the larger cities.

As previously stated, bids have been asked for upon other types than those which have been herein described, but on account of the high cost during the past two years, and because the cities of this class in this region are in the early stages of pavement construction, the types generally bid upon are those of simple construction and of lower cost. Decreasing cost and growth of paving construction will see the use of other types. The contracts let for paving, grading and curbs up to date this season have averaged approximately 35 per cent. higher than those contracted for during the season of 1919. The reasons assigned by contractors for this increase in price are: first, increase in cost of materials; second, higher labor cost; third, transportation shortages and delays, and, fourth, general uncertainty of industrial conditions.

These conditions indicate that if the program of hard surface roads is to continue, a much greater store of the necessary material, such as rock, gravel, sand and cement, must become available at reasonable prices, and wherever possible specifications should be so drawn up as to allow the use of local materials suitable for paving purposes, as the supply of high-grade crushed granite, quartzite and trap-rock is localized.

The foregoing matter is the major portion of a paper by Mr. Shepard, presented at the recent annual meeting of the Minnesota Surveyors' and Engineers' Society.

BITUMINOUS SURFACE TREATMENT OF BROKEN STONE ROADS

By Wm. W. Cox, County Road Engineer-Manager of St. Clair County, Port Huron, Mich.

The success of bituminous surface treatment of broken stone roads, depends upon the character and quality of the road, the selection and purchase of bituminous material, the preparation of the surface of the road, the subsequent application of the material, and the follow up or patrol maintenance.

The broken stone road should be constructed in the best possible manner, with good drainage, of the best possible grade of stone, and with chips properly keyed, rolled, watered and bonded, and with a slightly-crowned, smooth surface. In other words, bituminous surface treatment will not be a success on a yielding or poorly constructed road. A new road should be allowed to season as long as possible without damage by traffic, before it is given

the bituminous surface coating. If the road will stand a year without ravelling so much the better. Before surface treatment is given any road, its surface should be in a good hard smooth condition, or else the treatment is certain to be a failure.

On broken stone surfaces, the use of bituminous materials has been very satisfactory where proper materials were used, and where proper application was made. Oils are not suitable for general use in bituminous surfaces, because the medium heavy oils usually require too long a time to set up, and because most petroleum products act to a certain extent as lubricants, therefore they have a tendency to become rutted and bunched.

Favors Cold Applications

Asphalts and refined tars have been used very successfully as cold applications, and while they have been used as hot applications with varying degrees of satisfaction, yet the cold applications are the more satisfactory and dependable. When they are applied cold they should contain volatile fluids which serve only as the carrying agent. The objection to using hot bituminous material is, that they too readily become chilled when coming in contact with the road, and thus do not give the essential adhesion to the stone. If it is desired to use them as hot applications, the road should first be treated with cold bituminous material which is allowed to set or season, and thus afford a bond between the stone and hot material.

Bituminous materials should be purchased under proper specifications, with a furnished sample, which should be analyzed in the laboratory to determine if it satisfies the requirements of the specifications. When materials are delivered they should again be sampled and tested before being used. This procedure will protect the purchaser against inferior or unsuitable products, and against failures in his surface treatment work.

Prepartion of Surface to Be Treated

After the proper bituminous material has been selected and obtained, great care should be exercised in the preparation of the surface for treatment, because the success of the application fundamentally depends upon the proper union between the bituminous material and the broken stone surface. If this union or bond is not obtained the coating will shove, bunch, rut and peel off. Penetration is therefore not so desired, as is the adhesiveness of the bituminous material to the stone.

For cleaning the surface the most efficient method of procedure is to sweep thoroughly with horse sweepers, or with stiff hand brooms, the final sweeping to be done with brass or other fine fibre brooms. Care should be taken to remove all dirt, dust or litter clear of the stone, so that the whole stone surface presents a clean mosaic appearance. The broken stone surface at the edges along the berm is often covered with a mat of stone dust and litter which requires shoveling or scraping in order to remove it. Any remaining dust or loose material on any part of the surface will not permit proper adherence. A dry windy day is most suitable for cleaning the road. Too much caution cannot be taken to give a properly cleaned surface. After the surface is cleaned, the road should be closed to traffic if suitable detours can be provided.

Application of Bituminous Materials

Bituminous materials should be applied at the rate of ¼ to ½ gal. per square yard. They should be applied only when the temperature is above 50 degrees Fahrenheit, and when the surface is warm and dry. The methods of distribution most satisfactory are by use of gravity or pressure distributers. Pressure distributers are very much the better because they insure a more even application. When hot application is made the bituminous material should be covered immediately, with 13 to 15 lbs. per square yard of hard clean ¼ to ½-in. stone chips or pea gravel. The gravel or chips should be broomed over the surface and at once rolled with a roller (preferably the tandem type) weighing from 5 to 8 tons. When cold application is used, it is almost necessary that the road be closed unless it is wide enough to allow one-half the width to be treated at a time, thereby allowing traffic the use of the other half. The day following the cold application of bituminous material the surface should be covered with gravel or stone chips, and rolled the same as for the hot application before being opened to traffic.

When it is necessary to use ½ gal. per square yard in order to obtain the proper surface, it is economical to apply this in two operations, a day or two apart, and thus avoid waste. When too much is applied at one time the result is that the middle of the road is covered too thin and the edges too thick.

One important thing to be remembered in connection with bituminous surface treatments of broken stone roads is that a built up mat or wearing course is not the object, but rather a waterproof, dust-proof surface covering is desired. Subsequent treatments should have in view only an amount of material to be used which is needed to seal the surface, or to replace that which has been worn away. As soon as a road is treated and opened for travel, there will often appear patches or spots which will loosen or ravel. These places should be patched at once or they will soon become larger and permit moisture to penetrate the road. In order to insure satisfactory results, the road should be patrolled with a suitable outfit to keep the surface free from holes. When the greater part of the bituminous surface fails, it is best to remove it entirely and reconstruct.

Causes of Failures

The causes of failure of bituminous surfaces are numerous. The failures due to the condition of the road surface, may be primarily due to faulty or poor construction of the road or to improper preparation of the surface, in which are found many pot holes, ruts, dust or dirt pockets, either due to accumulation or to original construction. In many cases the stone has not been properly graded or bonded. Then again in many cases a damp or cold condition of the surface has resulted in failure.

The failures due to materials can be traced back to their faulty physical and chemical properties. They may contain lubricant or volatile constituents which make them unsatisfactory, because they require too long a period in which to set up and as a result they bunch and rut.

The failures due to faulty applications may be due to the use of too small an amount, or to an excess amount of bituminous material. Uneven distribution will also prove a failure. The lack of stone chips or pea gravel will cause the surface to remain sticky and unsatisfactory. The use of fine sand instead of the stone chips or pea

gravel should not be practiced, as there is a great possibility of the covering shoving and bunching, when it is increased in thickness by subsequent treatments.

Bituminous surfaces cannot be expected to be permanent, though by such treatments the water-bound macadam road is greatly preserved and protected.

Having a first class road, by the selection and use of proper materials, by their proper application, and by subsequent maintenance and care there is no doubt that bituminous surface treatment of broken stone roads will be a great saving and help in maintenance, and will at the same time make the broken stone road a very satisfactory road for the present day medium or light traffic.

Acknowledgment

The foregoing paper by Mr. Cox was presented before the recent Short Course in Highway Engineering at the University of Michigan.

RELATION OF GRAVEL SPECIFICATIONS TO PRODUCTION

By R. C. Yeoman, Extension Engineer, Indiana Sand and Gravel Producers' Association, City Trust Bldg., Indianapolis, Ind.

In locating a gravel plant, the gravel producer must first be sure of three things—a market, a deposit of gravel and transportation between the two points. In determining the size of his plant he must consider more carefully the deposit, its character, location, possibilities of extension. To illustrate briefly, in the district around Lafayette, Ind., where a bank from 50 to 200 feet is available, and with excellent transportation facilities, it is economical to build a large permanent steel plant. In the Indianapolis district where the deposits are shallow, underground and limited by the political divisions of the city, a large permanent plant would be uneconomical. The shallow deposits demand a small plant which can be easily moved, and unfortunately the smaller plants are necessarily less efficient than the large ones. However, there are deposits located outside the city where there is plenty of space, and greater plants are economically possible, but not in comparison with the more extensive deposits in the north.

Many Grades Cause Trouble

The market that calls for many grades of material makes trouble for the gravel man, especially where he must content himself with a small plant, his deposit is variable and so is his market. Some days his manufacture runs to sand and some days to gravel, and it often happens that on a day that he has a demand for sand the shovel is digging into a gravel bed, and vice versa. For plant economy he must balance the two or waste. The larger plants can furnish many grades of material but they are affected by the same change of deposit, and the plant manager is always juggling his orders so as to meet this variation.

Accurate Grading Increases Cost

Also specifications requiring accurate grading and careful division of product, affect the economy of production. There are two grades of material that are most common—sand and gravel. For arbitrary reasons, a one-fourth in. screen is used to divide the two. A plant which furnishes these two sizes and is required to divide accurately on one-fourth in. finds it difficult to make speed and accuracy go hand in hand.

A failure to make speed increases the cost. A failure in accuracy of grading may condemn the material. Therefore in making specifications that call for many specific sizes, or one which requires accurate grading, greater expense must be expected. To the engineer the problem may be this for example: For an accurate grading of material he shall pay $1.50 per ton. For one of variable gradation he shall pay 75c a ton. Now it is up to him as an economical problem to decide which of the two will give the best results for the least money. If his extreme requirements are of an experimental nature, the producer hesitates to supply it because he faces the problem of having to return to the old plan should the new requirements fail to bring the results intended. It is the duty of the engineer and producer to get together and work out the standard of speed and accuracy that gives the best material for the least money.

A recent study of the plant conditions in Indiana indicates a very wide difference in the equipment of these plants. A few, as mentioned before, are able to furnish most any kind of material specified, while others are limited to clean material but only a few grades, and then a great number who wash thoroughly but only divide their materials in two parts—sand and gravel. A sudden change of conditions in the smaller plants requires not only a demand from the engineer, but some certainty that there will be market sufficient to pay for the change.

Gravel Plant Conditions in Indiana

A recent study of the plant conditions in Indiana indicates a division of products as follows: For roads, 40%; for buildings, 33%; for ballast, 16%; other purposes, 11%. Amounts of sand and gravel sold indicate a division of 50% to each.

Since the plants are now equipped for handling the above distribution of business, a variation in specification requiring a serious change means additional expense, the amount of which cannot be determined in less than a season's run. However, that is one of the contingencies that the gravel producer must carry to some extent no matter what the conditions are.

Gravel is a very common building material and has been used almost indiscriminately for many years. Local practices in its use have sprung up all over the State and are slow to change.

The advance of civilization is demanding higher grade structures and consequently higher grade materials must go into these structures. Machinery is replacing hand labor, and more refinement is required as the processes of manufacture become more complex.

The road problem particularly is undergoing an important change. Only a year ago Indiana had one road law, which recognized the County Surveyor of each County in the State as an authority in his own district. Today Indiana has three road laws, and while the same

authority is still retained by the county surveyor in regard to the original law, the two new ones have created centralized control reaching through the State to the federal government. The effect of these laws will be to unify the conditions over the state, encourage the best talent, and eventually raise road building to a much higher plane. During the transition, however, the economic value of established customs should be considered.

The New Highway Commission have done much already toward standardizing the engineering of highways in the various counties. Their work is only begun. Producers are anxious that they succeed in bringing about the best road conditions possible. Many changes have been made and more will have to be made. With the proper co-operation between the engineer and the manufacturer, the change can be made without serious difficulty.

I have made a study of 20 typical specifications from various counties in Indiana, and I find that they are written particularly to fit the conditions in their respective counties, and my personal opinion is that a uniform specification, unless quite liberal, would be impracticable at this time.

To Unify Specifications in Middle West

Various associations of material producers are at the present time working in harmony with state highway engineers in the Mississippi Valley endeavoring to unify the specifications as to size and uses. When this work is complete it is expected to be a great step forward, and the very fact that it is a co-operative movement insures its success. I would advise that the engineers and the various local districts of the State watch this movement carefully and join in the standardization when the final details are determined. At the present time they should be careful that their descriptions include the materials which they are expecting to use. They can gain much benefit from the State Highway program in the matter of uniformity and expert opinion, but great care should be taken that some limitation is not made that would, because of market conditions in a very busy year, seriously hold up their program.

The result of another investigation inquiring as to the probable road building program for this coming year, indicates that Indiana proposes to spend three to four times as much in 1920 as in the best previous year. This will change the sales and give the road market the maximum over all other demands at the end of the coming year.

The established sand and gravel producers are making a provision for a possible 50 to 100% increased production over the previous year. According to past experiences this will more than consume all the transportation that will be available, and should there be a shortage of material next year the facts are it will not be due to low production.

The sand and gravel producers are anxious for a uniform product. They are determined on a well-prepared product, and they are willing to make any justifiable advance in the quality of their materials when a market for it is guaranteed, but if the experience of the past two or three years of inadequate transportation and erratic demand continues, the producer will experience difficulty in taking care of his normal share in the program. It is their earnest desire to co-operate, especially with the engineer, on whom much of the responsibility for the coming season's success depends.

The foregoing matter is from a paper by Mr. Yeoman before the annual meeting of the Indiana Engineering Society.

APPROVAL OF HIGHWAY BRIDGE PLANS IN INDIANA

By Wm. J. Titus, Chief, Bureau of Bridges, Indiana State Highway Commission, Indianapolis, Ind.

One of the important features of the work of the Indiana State Highway Commission is to assist the counties in the approval of plans and inspection of construction work as provided by both the County Unit and Highway Commission laws. County engineers are urged to make sufficient investigation of bridge sites to determine the proper amount of waterway and a proper depth of foundations, as a mistake in these may permit the total destruction of the most expensive structures.

It is hoped that the possibility of securing approval of bridge plans by the Highway Commission may help to secure a better type of submitted design at county bridge lettings. So long as there were no definite lines laid down for submitted designs, the conscientious designer was pretty much out of the running. There would always be some other designer who was willing to design a lighter and weaker structure and to take a longer chance that it would not fall down before the contractor succeeded in getting his final payment.

Two Chief Lines of Investigation

In the approval of bridge plans, there are two chief lines of investigation relating in brief, first to the sufficiency of the proposed structure from the broad standpoint of its fitness for the given location, its ability to pass the maximum amount of flood water and to carry the maximum loads which may be imposed upon it, and relating, second, once these points have been established, to its structural sufficiency. There is a very definite plane of demarcation between these two lines of investigation. The points mentioned in the first must be determined from an intimate acquaintance with, or investigation of, the conditions to be met at the site of the structure. In bridges on the state highways we can readily do this work, but in county work we believe that these features should ordinarily be established by the local officials, although I believe there is no reason why we should not, on request, undertake to pass upon this phase of the work.

Required Waterway

In handling this phase of our own work, we determine upon the required waterway by an investigation of a number of other bridges both up and down stream from the given structure, from the character and extent of the watershed, from the highwater marks as shown on adjacent brush and trees and from information from persons living near the stream; we determine the slope and

length of wingwalls from a study of the probable action of flood waters on the approach fills and we select the depths of foundations and make recommendations as to the necessity of driving foundation piling after making some soundings of the stream bed and digging a number of test pits. These test pits are seldom more than 4 or 5 ft. deep and do not give any information as to the desirable length of piling, should they be required. This must usually be determined by driving test piles after the contract is awarded.

Loading

All bridges on state highways are made with 20-ft. clear roadways and are designed to support concentrated loads of one or more road rollers weighing 20 tons each or a uniform load of from 85 to 125 lbs. per square foot of roadway, depending upon the length of span. I realize that these conditions may be somewhat more severe than is desirable for certain second and third class roads throughout the state but would urge that where a permanent bridge is to be built, very careful consideration be given to the probable future uses of the structure and the certain future increase in both amount and weight of traffic. County engineers are particularly urged to see that the foundations of piers, abutments and wingwalls are placed at such a depth below the lowest point in the bed of the stream and spread over such an area that the life of the entire structure will not be in danger.

The work of approving submitted plans will therefore be greatly facilitated if those features which the county engineer should determine are set out in either the plans or specifications. It is not unusual for bridge plans to come in for approval without any loading being specified or any word as to the probable allowable soil reaction. If you suggest that neither of them is known, I reply that it is not possible to design the structure without making some assumption as to both of them. I give below a table showing allowable soil pressures as worked out by the Indiana Highway Commission. These are of course only assumptions and, like prices on roadbuilding materials these days, are subject to revision without notice.

SAFE BEARING VALUES OF SOILS

Character of Soil	Safe Working Loads in tons per sq. foot
Loam, silt or quicksand	.5 to 1
Soft or wet clay	1 to 2
Fine Sand or Medium Clay	2 to 4
Hard dry clay, gravel or coarse sand	4 to 6
Hard-pan or very dry clay	6 to 8
Cemented gravel	8 to 10
Rock (Poor brick masonry)	5 to 10
Rock (Best brick masonry)	10 to 20
Rock (Best Ashlar masonry)	20 to 30
Very hard bed rock	30 to 100

Our standards as to structural sufficiency are in the main those of the U. S. Bureau of Public Roads. The amount and distribution of forces and the maximum allowable stresses are generally set out in our standard bridge specifications. We have no desire to be arbitrary as to the amount of detail shown on the plans, but certainly there should be sufficient information to show quite clearly the exact extent of the work to be done.

Acknowledgment

The foregoing is from the address by Mr. Titus before the recent Purdue Road School.

DETOURS UNNECESSARY WHILE LAYING BITOSLAG ON OLD FOUNDATIONS

One of the obstacles presented in road building is the disposition of traffic during construction work. Generally long and tedious detours are necessary over very poor roads. Despite the fact that it is in a good cause and only a temporary expedient, detouring causes much dissatisfaction among road users and results in strong complaints from that portion of the public. It also causes additional expense to users of a road on account of lost time.

Many of the various types of road construction necessitate a closed road during progress of work and consequently a detour. When "Bitoslag" pavement is laid on an existing foundation detours are unnecessary. The "Bitoslag" mixture sets up immediately after rolling and traffic is allowed to pass over the pavement immediately a load of mixture is spread and rolled. This is an operation which does not require many minutes—in fact, the delay occasioned to road travelers is hardly greater than the time ordinarily lost at a busy intersection in a large city when held up by a traffic officer.

An example of the peculiar ability of "Bitoslag" to withstand traffic occurred during the construction of a Pennsylvania state highway in Luzerne county, near West Nanticoke, several years ago, when a large tractor passed over the pavement immediately after being laid and no evidence was shown that the pavement was injured.

Where a new foundation must be laid detours are, of course, necessary, but the main point of this article is that "Bitoslag" can be laid on old macadam, old brick or old concrete without necessitating detours during construction.

CITY PLANNING IN ST. PAUL, MINN.

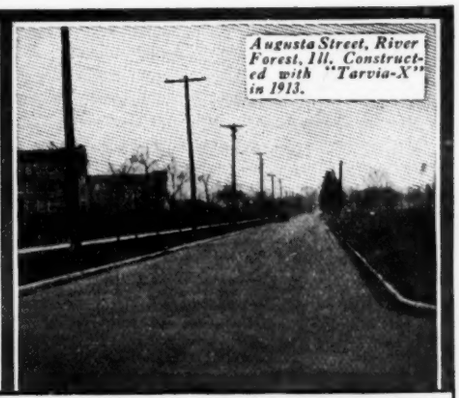
George H. Herrold, M. Am. Soc. C. E. Office Engineer, Department of Public Works, St. Paul, Minnesota, was appointed managing director and engineer of the St. Paul City Planning Board, effective March 15, 1920.

This is a newly created position brought about by ordinances providing for a City Planning Board, to study the physical conditions of the city and prepare a comprehensive plan for its future development.

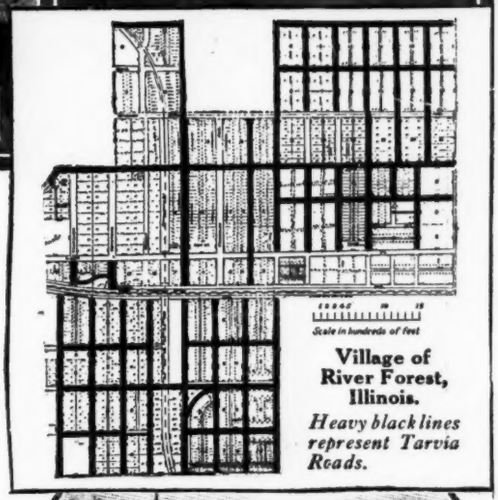
Also all matters concerning or relating to the platting of new areas or replatting of existing areas; the vacation or rearrangement of boulevards, streets or alleys; the routing or rerouting of street cars and other means of transportation; the assignment of traffic to particular arteries of travel; the location and development of parks, playgrounds, parkways or other public places; the location and design of all public buildings, bridges, monuments and street fixtures; the establishment of building lines; the establishment of restricted building districts; and all other matters relating to the planning or replanning of the city will be referred to the City Planning Board for its consideration and recommendation at such times as the council may direct before final action is taken thereon by the council.

The City Planning Board of Saint Paul has been in existence about a year and has during that time created a public sentiment which has resulted in their securing an appropriation of $50,000 to be expended during the next two years for surveys and a plan.

Oak Ave., River Forest, Ill. Waterbound macadam, maintained with Tarvia.



Augusta Street, River Forest, Ill. Constructed with "Tarvia-X" in 1913.



Village of River Forest, Illinois.
Heavy black lines represent Tarvia Roads.

The Best Streets in Cook County—

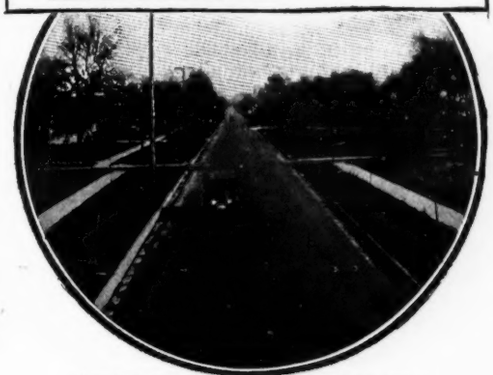
IN 1912 the Village of River Forest, Cook County, Ill., began using Tarvia for constructing and maintaining its streets. This is the same County in which the City of Chicago is located.

After seven years of experience with Tarvia, and with Barrett service, Mr. Arthur S. Hatch, Village Clerk, writes us this letter:

> "I wish to express to the Barrett Company my appreciation for the excellent services rendered the Village of River Forest, both as to the Tarvia furnished and the satisfactory application of same to our pavements.
>
> "As you know, nearly every macadam street in our village is treated with Tarvia, and we believe that we have the best streets of any city, town or village in Cook County."

It is one thing for a community to use a road material occasionally for some special purpose. But it is quite another thing—and very much more of a proof of the material's worth—to have the community adopt that material and use it in increasing quantities, season after season, as River Forest has done with Tarvia.

The black lines on the map are most effective proof that River Forest's village authorities and taxpayers alike are strong for Tarvia. Tarvia gives them mudless, dustless, automobile-proof roads at low cost, and after all, that is what every community is looking for, isn't it?



Above Washington Blvd., looking east from "Soo" R. R. viaduct, River Forest, Ill. Waterbound macadam treated with "Tarvia-B" in 1914 and 1916. "Tarvia-A" in 1918 and 1919.

Illustrated booklet telling about the various Tarvia treatments, free on request. Address nearest office.

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by any one interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will have prompt attention.

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WATER WORKS SECTION

EXPERIENCES WITH AIR LIFT PUMPS

By W. G. Kirchoffer, Sanitary and Hydraulic Engineer, 22 N. Carroll St., Madison, Wis.

Are air lift pumps designed according to the laws of hydraulics and pneumatics or are they guessed at? To one who is not altogether familiar with the principles of these pumps there is a great deal of mystery about them, hence the above question.

Some writers and manufacturers of air lift pumps who profess to understand the mysteries of them would have us believe that the success or failure of the air lift pump depends largely upon the characteristics of the well operated upon. To this assumption (or theory) I cannot wholly agree; my experience has not borne out such contentions. I was much interested recently in reading an article by an engineer of one of the largest air lift manufacturers, published in Municipal and County Engineering for November, 1919. Much that he says is of interest to those who are not experienced in the design and operation of these pumps and such advice as he gives is good. However, I cannot agree with what he contends are the principal causes for failure of a given installation, or his statement as to a master formula. Possibly what he really means is that there is no master formula by which the specific capacity of any and all wells can be determined. To this statement I must heartily agree.

He, like most writers for engineering journals, does not give all the facts and secrets of the business; he leaves much to be guessed at. I can see no disadvantage to the engineer or manufacturer in "laying all the cards on the table face up."

Analysis of Data in a Former Article

In the above mentioned article the author gives as illustrations of his contentions, the installation of two air lift pumps, both on wells apparently alike, but which proved to have widely different characteristics. In the case of the Texas well that produced 530 gals. per minute with 30 cu. ft. of air which he says is phenomenal, let us analyze the data given and see what we find. If we refer to "Compressed Air," by Elmo Harris, page 80, we will find that by substituting gallons per minute for cubic feet per minute and allowing for no losses, we would have for 100 per cent. efficiency, the following formula:

$$V_a = \frac{h}{580 \log \left(\frac{s+34}{34}\right)}$$

in which V_a equals cubic feet of air per gallon, h equals lift and s equals submergence. This formula is derived on the assumption that the work done by the air in expanding isothermally is equal to the work done on the water and neglecting frictional losses. If in this formula we insert the values given for the Texas well h equals 20 and s equals 200 minus 20 equals 180 ft., we will find that V_a equals 22 8 cu. ft. That is to say, if there were no losses whatever, it would require this amount of air to produce 530 gals. of water per minute. If we neglect the losses that might occur in the foot piece (patented part) and consider only the entrance, pipe friction and exit (velocity head) losses, based on hydraulic tables for flow of water, we would find that the entrance losses were 0.31 ft., the frictional loss 8.08 ft. at bottom, 12.2

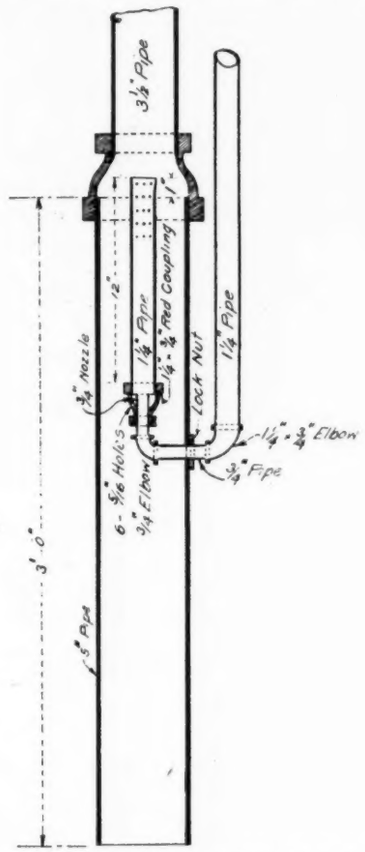

FIG. 1. AIR LIFT PUMP AT WISCONSIN STATE PRISON.

at top, average 10.14 ft., exit loss 0.97 ft., total 11.40 ft. See Hazen and Williams, tables page 24.

The amount of air required with these losses considered is 35.6 cu. ft. There are other losses which we have not considered which must certainly exist, such as loss by impact in the foot piece, slippage of water past the air, loss of head, etc.

It, therefore, would hardly seem consistent with good scientific reasoning to credit the 30 cu. ft. of air with having pumped the 530 gals. of water per minute. What probably happened is that the 30 cu. ft. of air increased the velocity of the water in the well to such an extent that the natural flow was greatly increased because of the opening of crevices and the cleaning out of the well. Or it may be that the compressor actually produced more air

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than the above mentioned 30 cu. ft. At a water works plant in Wisconsin, where I was engaged to design and superintend the addition of an air lift pump on a flowing well, the application of the air increased the natural flow after the air was shut off.

If we are to analyze further the installation we will find that the per cent. of submergence is 90, greatly in excess of that actually needed or recommended by the best authorities. According to bulletin 71A of the Sullivan Machinery Co., page 15, the submergence should be 70 per cent. to 66 per cent. for this installation. These percentages would give the actual submergence from 47 to 39 ft. The pressure required under these assumptions would have been 21 lbs. to 16.9 lbs. That actually used was 78 lbs.

The actual horse-power required to compress 30 cu. ft. of air under the conditions as installed was 4.68 H. P. That which would have been sufficient under an economical installation would have been $(6.38\times.30)=1.9140$ H. P. From the standpoint of economy, was the installation so very remarkable after all? It is evident in this case, efficiency was sacrificed for the sake of quantity. As to the weaker well cited at Fort Dodge, Iowa, I contend that had the flow of the well been confined in a pipe and the height to which it would rise determined, or better yet, a test with a small pump applied, they would have found that the well had no relation to the well in southwest Texas.

My experience with air lift pump installations would lead me to believe that they have been made more on the assumption that because a well of certain size, depth, etc., at one place gave good results, the same size of pump, submergence and other characteristics would do likewise at another installation.

Installation at Platteville, Wis.

For many years I was very much opposed to the use of air lift pumps on account of their reported inefficiency. It was not until the year 1909 that I had the opportunity to test one of them and to write specifications for a new installation at Platteville, Wis. The old air lift pump was a "straight air" installation of 375 ft. of 1¼-in. pipe in a 6-in. well. Water was 110 ft. from the surface. The test consisted of weighing the coal burned and measuring the water pumped into a surface reservoir. It required 30.12 lbs. of coal to raise 1,000 gals. of water.

The new installation was to be in a 16-in. well 1,000 ft. deep and located about 150 ft. from the old well. The specifications gave every liberty to the builder that he might ask for, he being limited only by the size of the compressor on hand, and his guarantee as to the saving in coal he was to make. One of the bids submitted specified that they could save us 25 to 50 per cent. of the coal, would supply 350 gals. per minute and would operate at 70 lbs. pressure. The bid was accepted and the pump installed. The first test showed clearly that the pump was not large enough to produce the 350 gals. per minute at any submergence or at 70 lbs. pressure. This pump was removed and another larger one installed. This was tried out at three different submergences, none of which would work at 70 lbs. pressure or supply the amount of water specified. The best results were obtained when pumping 337 gals. per minute with 381 cu. ft. of air at 102 lbs. However, the consumption of coal was reduced to 15.83 lbs. per 1,000 gals. No doubt, this was partly due to the fact that one well was 16 ins. in diameter and the other 6 ins. The pump was purchased, but it now lies in a scrap heap and a deep well plunger pump is doing the pumping.

Slightly previous to this time I had made a test at Elkhorn on a "straight air" installation. I asked this same company to make me a bid on a better and more efficient pump. I received the proposition all right, but by analyzing it I found their pump would not go inside the well or operate at the pressure specified so I did not recommend to purchase it.

Several similar pumps were installed at a city near Milwaukee, but they all have been replaced by pumps made by the local superintendent who claims his pump to be superior to the patented ones.

Installation at Wisconsin State Prison

This experience so completely disgusted me with any patented foot piece that I did not consider another installation of air lift pumps until in the year of 1917 when I was experimenting on the city water at Wausau for the removal of iron and manganese. I installed five home-made pumps of my own design. These were never tested carefully for efficiency but operated much more steadily than any pump I had then seen, and by rough calculation on compressor displacement, were using a very small quantity of air per gallon. Shortly after this I was called upon by the chief mechanical engineer of the state of Wisconsin to advise him on the air lift pump that had been installed at the Wisconsin state prison. This well is 10 ins. in diameter and about 800 ft. deep. Water stands 31 ft. from the floor level. This pump was equipped with a foot piece patented by engineers at the prison and consisted of a cone shaped casting with small nozzle in the center. This was placed in the well 132 ft. from the top. It required 85 lbs. pressure with compressor running at full speed to raise 158 gals. per minute. The lowering of the water was 13 ft. 4 ins., the total lift about 60 ft. and the submergence 72 ft. I therefore recommended a new installation based on my experience at Wausau. The foot piece was made entirely of pipe and fittings and consisted of a piece of 6-in. pipe 3 ft. long with nozzle made of 1¼-in. pipe. The top of the 1¼-in. pipe was flared out to a thin edge and the increaser at the bottom was drilled with six 5/16-in. holes to allow water to enter the 1¼-in. pipe about the ¾-in. air outlet. See Fig. 1.

The theory of this nozzle was that by mixing a small quantity of water with the air an emulsion would be produced which would be more efficient than just large "bubbles." This pump was installed and tested very carefully with the result that with compressor operating as before but with a pressure of only 55 lbs., 245 gals. per minute were discharged. This was such a material gain over the former foot piece that I became much more interested in the air lift pump and began a scientific as well as a practical investigation of the workings of these pumps. Mr. John C. White, Capitol Power Plant Engineer, did not take much stock in my emulsion theory of a mixture, so he built a pump in his power plant of 2½-in. pipe, 65 ft. long. He made a foot piece of cast iron with plate glass windows on each side so that we could observe the action of the air and water in the nozzle. See

Fig. 5. He also built a meter for measuring the air as it entered the foot piece. Several test runs were made simply for observation purposes, but later it was decided to run two series of tests, one with the nozzle to break up the air into fine bubbles such as I had used at Wausau and one with a single large opening which Mr. White contended was just as good.

The water was measured by a 1½-in. water meter properly tested. Thirty-five sets of readings (10 in each set, total 350) were made on each nozzle. The water pumped varied from 12 gals. per minute to 60 gals. per minute and the submergence from 30 per cent. to 75 per cent. The results were reduced so as to show cubic feet of air per gallon. From these 700 observations the following deductions were made.

Deductions from Tests

Out of these comparative tests in which the gallons per minute pumped and the submergences were the same for each nozzle, 40 per cent. of these were in favor of the straight nozzle by an average of 0.02444 cu. ft. of air per gallon. The maximum difference was 0.3485 and the minimum 0.0006 cu. ft. per gallon. Sixty per cent. of the tests were in favor of the special nozzle (designed to produce fine bubbles) by an average of 0.0232 cu. ft. of air per gallon. The maximum difference was 0.0915 and the minimum 0.0023 cu. ft. of air per gallon.

During the test, observations were made on the operation of the nozzles. Instead of the water entering the special nozzle at the bottom, air came out when high velocities were used. The bubbles, however, were small and numerous. Observations made on a pump entirely of glass revealed the fact that no matter how fine the bubbles were at the foot piece, they soon joined into large ones a few feet above the point of entrance.

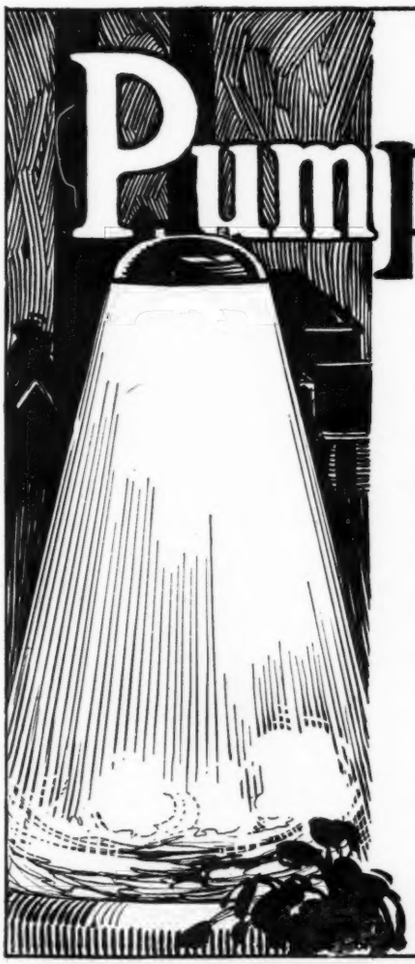
These tests would appear to prove quite conclusively that any attempt to break the air up into fine bubbles is useless, that a plain straight open nozzle is as good as any foot piece that uses a nozzle at all. Professors Corp and Ward, of the Hydraulic Laboratory of the University of Wisconsin, became interested and directed the tests.

These tests were then followed with several hundred more observations to determine the loss of head in the eduction pipe and to find the submergence and capacity for highest efficiency with an 2½-in. eduction pipe which tests have not as yet been completed and made available for publication.

Installation at Southern Wisconsin Home, Union Grove, Wisconsin

During the time these tests were in progress I was called upon to design a pump for the Southern Wisconsin Home, at Union Grove, Wis. This well was 10 ins. in diameter to a depth of 255 ft., 8 ins. to a depth of 800 ft., and 5 ins. to a depth of 1,065 ft. Before pumping the water stood at 120 ft. and during a pumping test lowered to 165 ft. and produced 62.6 g.p.m.

An air lift pump was designed for 60 gals. per minute



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and consisted of a home-made foot piece of pipe and fittings similar to the one used for test purposes. Eduction pipe was composed of 200 ft. of 2-in. pipe, 122 ft. of 2½-in. pipe and 45 ft. of 3-in. pipe with increasing couplings between them. It was estimated that 48 cu. ft. of air per minute would pump this amount of water and that the pump would operate at 95 lbs. pressure. On completion of the installation the pump was tested and found to deliver 64.4 gals. per minute with 48 cu. ft. of air.

Installation at Mendota State Hospital

At Mendota State Hospital a rotary deep well pump was replaced by one of these pumps. Here the well conditions were 15-in. well 700 ft. deep. Water stood at 89 ft. from the surface. The new pump was designed to discharge 300 gals. per minute with 175.5 cu. ft. of air under a pressure of 69½ lbs. This installation being so near the University of Wisconsin and the Capitol Power Plant, we made a very careful test with air meter, etc.

Installation at Sparta, Wis.

It was found that 118 cu. ft. of free air at 74 lbs. pressure raised 307 gals. per minute. Recently a similar installation was made at the water works plant at Sparta, Wis. Here a 10-in. well 293 ft. deep flowed about 200 gals. per minute into a ground water well-reservoir. The pump was designed to discharge 500 gals. per minute with 100 cu. ft. of free air at 30.3 lbs. with an estimated lift of 30 ft. Here it was somewhat difficult to make an accurate test because the pump discharged into a ground water well whose filling curve was not known with accuracy. However, a relatively close measurement gave 491 gals. per minute with 100 ft. of air (70 per cent. of volumetric displacement). The lift was about 27 ft.

The above installations were on four wells no two of which had the same static lift or drop of head due to pumping and yet it has been possible to design pumps for them that have produced almost exactly the amount of water, pressure and air consumption that was estimated. All of these pumps were designed with variable diameter eduction pipe and for velocities of 12 to 15 ft. per second at the bottom end of the pipe and 25 to 30 ft. at the top. Would not this brief experience somewhat refute the statement that no master formula could be used for all installations? Would it not also show that what is lacking is proper knowledge of the specific capacity of wells rather than that the master formula is lacking?

Formula Pertaining to Air Lift Pumps

Various attempts have been made to derive formulas to express the relationships existing in an air lift pump. In bulletin 58-L, page 35, of the Sullivan Machinery Co., is given this formula:

$$V_a = \frac{h}{292.5 \log \left(\frac{s+34}{34}\right)}$$

in which V_a = cu. ft. air/gal/min.
h = lift in feet.
s = submergence in feet.

292.5 is a factor which takes care of the losses and is sometimes varied as the lift increases. This same formula is given by Gardner Governor Co. with factor equal to 234. Its form is the same as the one cited above.

This formula, though somewhat empirical, is of the same form that has been derived by Mr. Elmo Harris and is given in "Compressed Air," page 80. The Hudson Engineering Co. a number of years ago also gave a calculus demonstration of the derivation of it. It can, however, be derived in a very simple manner by equating the work done in compressing the air with the work done in raising the water and allowing for a factor to take care of the fact that the apparatus is not 100 per cent. efficient, this formula would be as follows:

$$V_a = \frac{h + h_i + h_f + h_o}{E\ 580 \log \left(\frac{S+34}{34}\right)}$$

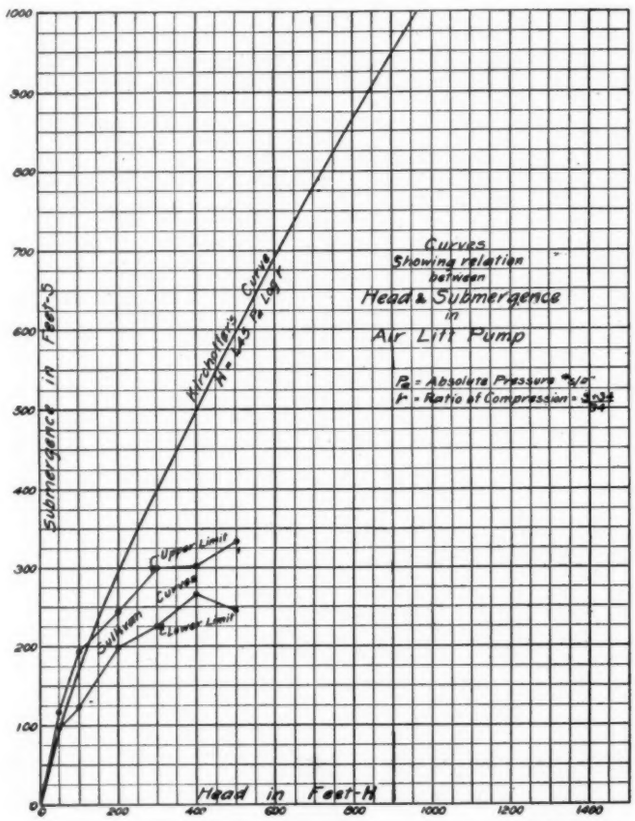


FIG. 2. CURVES SHOWING RELATION BETWEEN HEAD AND SUBMERGENCE IN AIR LIFT PUMP.

In which the factors are as above with h_i equal to the head lost at the inlet of the pump, h_f the head lost in friction of the water and air passing up the eduction pipe and h_o the head lost at the outlet. All of these are unknown and experiments made to determine them have not been given to the public so far as I am aware, but instead the constant or factor "C" has been varied partially to account for them, but cannot be considered as an absolute off-set for them because the diameter of the pipe, the conditions as to roughness and the velocity of the mixtures would all affect h_f. The valve of "C" as determined by the tests at Mendota was 315 and has been used successfully on designs made since. There is no reason why close approximations cannot be made to these by using tables for loss of head in pipes for the flow of water and air.

The efficiency depends quite largely upon the value of V_a for a given installation and upon the submergence. No definite rules have so far been made public for the determination of S for any given value of h which has

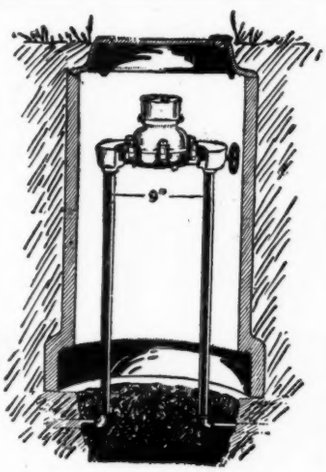
been based on theoretical considerations. Sullivan Bulletin 71-D gives the following table based on experience:

Head in feet	Submergence per cent.
For lifts up to 50 ft.	70 to 66
For lifts from 50 to 100	66 to 55
For lifts from 100 to 200	55 to 50
For lifts from 200 to 300	50 to 43
For lifts from 300 to 400	43 to 40
For lifts from 400 to 500	40 to 33

So far we have been considering the actual volume of free air applied to the pump and have expressed it in terms of cu. ft. per gallon of water pumped. It is to be noted that the volume of free air required per gallon varies with the lift and with the submergence.

From our study of these pumps it would seem to be reasonable to assume that the actual volume of compressed air per gallon of water at the foot piece, for most efficient working conditions, should be constant for all lifts. Such relationship is expressed by the formula $h = C' P_a \log r$ in which $C' =$ an empirical constant derived from experiments, for Mendota pump it is equal to 1.45, h = lift in feet, P_a equals absolute pressure of air at the foot piece in pounds per square inch and r equals the ratio of compression or $\frac{S+34}{34}$. This formula expresses from a theoretical standpoint the relation between h and S.

Fig. 2 shows the above formula graphically for Men-



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Location of Pump	Kind of Pump	Depth of Well	Length of Pump	Diameter of Well	Starting Pressure at Well	Operating Pressure at Well	Cu Ft of Air per Min. 71% of Vol at Displacement	Diameter of Eduction Pipe	Gallons Pumped per Min.	Cu. Ft. of Air per Gal	Lowering of Water in Well	Total Lift in Ft.	Submergence in Feet	Percentage of Submergence	Efficiency	Static Distance to Water	Constant in Formula for Air per Gal
Platteville	Straight Air	1606'	375	6	115	36	302.6	6-1¼	235	1.29	44.0	154	221	59		110'	136
Platteville	Patented Foot Piece	1000	365	16	114	102	381.0	5	3362	1.128	27.7	1377	227	63		110'	142
Wis. State Prison	Own Make	600	180	10	57½	49	84.85	3½-5	200	0.425	17.35	634	1164.8	648	31.275	43.75	230.5
S. H. for F. M.	Own Make	1065	367	8	107½	54	48	2-3½	64.4	0.746	45	165	220	622		119	250
Mendota Asylum	Own Make	700	250	15	75	74	116	3½-5	307	0.383		91	159	636	53.7	83	315
Sparta Waterworks	Own Make	293	113	10	30	37	100	4½-5	491	0.204	27	27	88	765		0	315

$V_a = \frac{H}{C \text{ Log } \frac{S+34}{34}}$

V_a = Cu ft of Air per Gallon
H = Lift in feet
S = Submergence in feet
C = Constant*

W. G. Kirchoffer
Hyd & San. Engr
Madison, Wis.

FIG 3. RECORDS OF TESTS OF AIR LIFT PUMPS.

dota pump conditions and its comparison with the Sullivan table.

Conditions Affecting Efficiency

My experience in this practice as a designer of air lifts and with the thousand or more tests I have taken part in, would indicate to me that the losses that take place in the inlet, eduction pipe and outlet, have more to do with the efficiency of the air lift pump than does any form of nozzle in a foot piece. The mistaken idea is often advanced that there is energy in the jet of air that can be used similar to the use made of a water or steam jet. This is a fallacy for the reason that the weight of air used is extremely small and its kinetic energy is extremely small. It is also quite evident from experiments and practice that the eduction pipe, except possibly for low lifts and small quantities, should be of variable diameter with small end down. That any nozzle or other contrivance in the foot piece is an obstruction rather than an aid to efficiency.

Tests are now in progress under the direction of Prof. Ward on a foot piece with no nozzle or other obstruction in it. These experiments bear out the above statement. I also believe that foot pieces should not be made in job lots as other pumps are made, but should be made for each installation to meet the conditions found in the well.

I also believe that where the size and depth of the well will permit, one installation can be made as efficient as another, but the conditions to be dealt with must be known. When gangs of wells are to be pumped by the air lift, interference curves should first be determined.

Promising Future for Air Lift Pumps

I have also changed my mind as to the usefulness of the air lift pump. When properly installed it can be made nearly as efficient as the deep well plunger pump and when considered over a period of years, the total cost of operation, repairs, lack of service (pump out of repair) it would show up better than the average deep well pump. I also believe that air lift pumps in the future will be used extensively for the pumping of sewage and especially so for the removal of sludge from sedimentation basins. My brief experience on the Madison plant convinced me of this fact.

Tests on "Straight Air" Pumps

Sometimes efficiency has to be sacrificed on account of well conditions or because of the necessity for a large quantity of water is more important than efficiency. At Burlington, Wis., I recently tested some "straight air" pumps at the city water works wells. All of these wells were cased with packers at the bottom ends which were held in place by springs engaging the sides of the well.

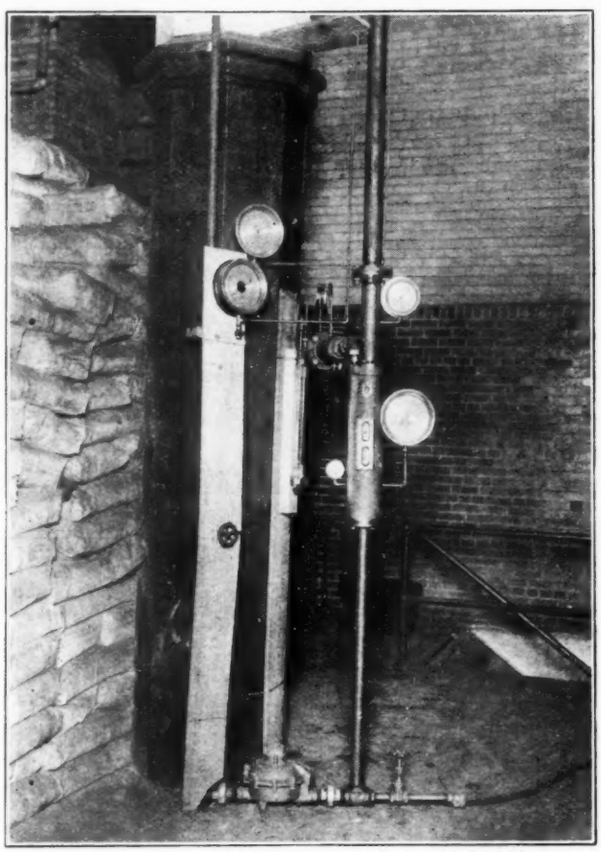


FIG. 5. TEST PUMP AT CAPITOL POWER PLANT, SHOWING WATER AND AIR METERS, OBSERVATION WINDOWS AND GAUGES.

This construction precluded the installation of the pumps at a sufficient depth to get correct submergence. The size of the wells prevented the installation of eduction pipes with separate air pipes. Two of the wells were changed over from "central air pipes" to central eduction pipes, using the casing as an air pipe. The foot pieces consisted of a short piece of slotted pipe with flaring mouth. In the 6-in. well, the eduction pipe was increased from 3½

No. of Tests	Date When Tests	Operating Pressure at Well	Cu Ft of Air per Min 71% of Vol of Displ	Gallons Pumped Per Minute	Cubic Feet of Air Per Gallons	Air H.P. Delivered to Well	H.P. in Water Pumped	Efficiency	Total Length of Air Pipe	Diameter of Air Pipe	Diameter of Discharge Pipe	Diameter of Well	Depth of Well	Static Distance to Water	Total Lift	Submergence
1	Oct 23-1918	*3-27*	150.0	293.5	.51	11.18	2.20	19.70						30'	19'-20'-42"	89'-71'-66"
2	Mar 18-1919	27	147.75	352.0	.42				120'	6-3½	3½-4½	8"		30'	60.0	60.0
3	Mar 18-1919	28	148.0	334.0	.443				120'	6-3½	3½-4½	8"		30'	570	630

Remarks: Well *3- Bell Mouth only, 4-$\frac{1}{8}$" Hole, 40' Above*
Well *3- Bell Mouth with 4-$\frac{3}{4}$" x 8" Slots Above
Well *2- 40'-2" Pipe with $\frac{1}{2}$" Holes in Sides, Bal. 1¼" Pipe
Well *1- Old Piping, Well Casing Grouted
Well *3- with Holes 40' Up, Well *2 as above*

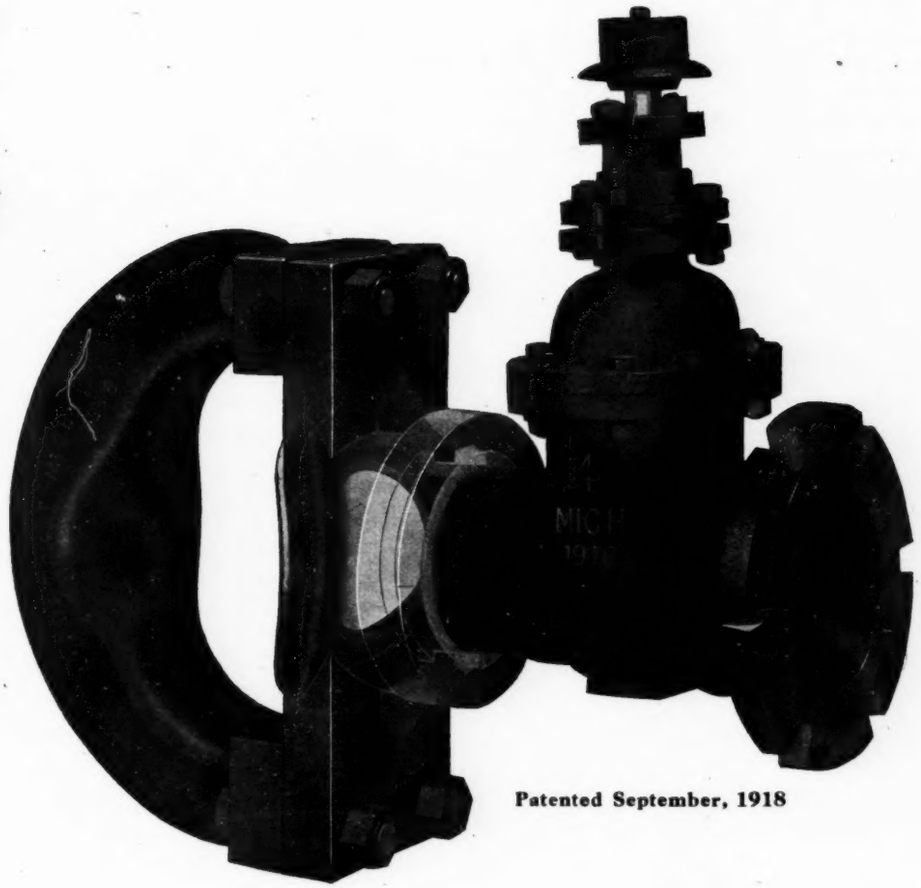
Water measured in Reservoir
35'-4" x 26'-6" x 12'-6" deep
Capacity per inch of depth 584 Gals.

Compressor, Duplex
11" diam x 12" Stroke
Capacity per stroke
264 cu ft.

$V_a = \frac{L}{C \text{ Log } \frac{H+34}{34}}$

V_a = Cu ft of Air per Gal.
L = Lift in Ft
H = Submergence in Ft C = Constant*

FIG. 4—RECORDS OF TESTS OF AIR LIFT PUMPS AT THE CITY WATER WORKS AT BURLINGTON, WIS.



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to 4½ ins. in diameter. The results of the tests before and after the changes were made are given in Fig. 4. These results are not at all comparable with those for the pumps at the prison, Southern Wisconsin Home, Mendota or Sparta water works as given in Fig. 3.

It is of interest to note the effect of placing four ⅛-in. holes in the eduction pipe 40 ft. above the foot piece in the No. 3 Burlington well. They caused a loss of 18 gals. per minute and an increase in air consumption of 0.023 cu. ft. of air per gallon.

In conclusion I wish to express the opinion that if other engineers, manufacturers and patentees interested in the air lift pump would publish the results of their experiences and tests similar to those given in this article, we might all help to solve some of the difficult problems connected with this work and in the end get something that would be really constructive rather than to continue guessing and dealing in generalities.

PREWAR AND PRESENT REPRODUCTION COSTS OF WATER WORKS

By L. R. Howson, of Alvord & Burdick, Hydraulic and Sanitary Engineers, Hartford Bldg., Chicago, Ill.

Anyone who has had occasion to purchase water works construction materials at reasonably frequent intervals in the past five years has been impressed with the almost continuous upward trend of prices for those materials, along with practically all other commodities. We all know, in a general way, that cast iron pipe, which, prior to the war, varied in price from $25 to $35 per ton, is now costing from $70 to $75 per ton; that brick, formerly $6.50 per thousand, now costs $14, and that labor, formerly plentiful and efficient at 20 cts. per hour, is now getting from 40 to 45 cts. per hour, and is less efficient than formerly. Probably few of us, however, have had occasion to investigate the effect of these increased unit costs upon the total cost of constructing or of reproducing complete water works properties, and it is to throw some light on this question that this paper is prepared, said Mr. Howson in addressing the Illinois Section of the American Water Works Association.

Prior to the war, the most commonly used measure of value in appraising water works properties, was the estimated cost to rebuild or reproduction, using as a basis for the estimate of future prices the average of the prices which prevailed during, say, the five-year period prior to the date of valuation. Obviously, reproduction is a rebuilding process of the immediate future, and the prices used involve a forecast of future prices and construction conditions just as they do in all normal engineering construction; however, in normal times, prior to the war, materials fluctuated in a series of cycles, with a gradually rising trend, and a very good idea of the near future prices was therefore possible by a study of the prices of the five-year period preceding.

Reproduction Costs of the Future

Within the last five years, however, construction prices and conditions have changed, and the question now arises as to where the reproduction costs of the future will probably lie. On several recent boards of arbitration, selected to fix the value of water works properties, two estimated costs of reproduction have been made; one on a prewar basis of unit prices, and the second on the basis of present day prices, and the value reasoned from these limiting estimates.

There are few well-informed people who will contend that prewar prices will ever again prevail in our time, and, accordingly, a cost of reproduction, using prewar prices, represents in all probability a minimum measure of the value of the property.

Most appraisers are also of the opinion that the crest of prices has been nearly or quite reached, and that, beginning soon, there will be a slow and gradual recession in prices to some new level intermediate between the prewar and the present. Accordingly, a reproduction estimate made, using the present price basis, represents approximately the maximum value of the property to those who hold this opinion.

In Table I, herewith, are shown the average prices of the more important water works construction materials which prevailed during each of the years from 1909 to the present. This table simply shows facts with which most of us are more or less familiar.

Table II shows the results of cost of reproduction estimates made for six water works properties during the past year on both the prewar and the present price bases, and illustrates the effect of the fluctuation in unit prices on the total cost of reproducing the property.

In the ordinary water works property from 50 to 75 per cent. of the total value lies in the distribution system, and, for this reason, we have shown in the fourth column of this table the relative proportion of the distribution system cost to the entire plant cost both based on prewar units. The distribution system materials have increased in relatively greater proportion than have other water works materials, and, accordingly, the greater the proportion which the distribution system is of the entire property the greater will be the cost of reproduction at present prices as compared to prewar prices.

The data in this table show that:

1st. For a property in which approximately 50 per

TABLE I—AVERAGE PRICES FOR WATER WORKS MATERIALS, 1910-1920

Material	YEARS									
	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919
Cast iron pipe 6 in. f. o. b. Chicago...	$26.92	$24.11	$26.17	$26.83	$24.21	$24.54	$31.25	$54.90	$57.85	$57.97
6-in. valves	12.50	12.50	12.50	12.50	12.50	12.50	16.50	19.50	21.00	22.50
2 nozzle hydrants	25.00	25.00	25.00	25.00	25.00	25.00	34.50	41.50	49.50	49.50
⅝-in. empire meters	10.40	10.40	10.40	10.40	10.40	13.25	14.10	14.10	14.10	14.10
Cross compound pumps per M. G. Cap.	3000.00	2700.00	2500.00	2500.00	2500.00	2500.00	3300.00	7500.00	7500.00	7500.00
Lumber, dealer's price	26.00	26.00	26.00	26.00	24.00	28.00	28.00	40.00	43.00	58.00
Cement (net)	1.25	1.25	1.25	1.25	1.15	1.15	1.43	1.78	2.00	2.00
Brick (Chicago)	6.50	6.50	6.50	6.50	6.50	7.00	7.00	9.00	12.00	14.00
Steel bars	1¾c	1¾c	1¾c	2.1c	1.9c	1.9c	3.5c	6.4c	4½c	4c
Common labor, Central Illinois	20c	20c	22c	22c	22c	22c	25c	28c	35c	40c
Teams	40c	40c	40c	40c	45c	50c	60c	70c	75c	80c

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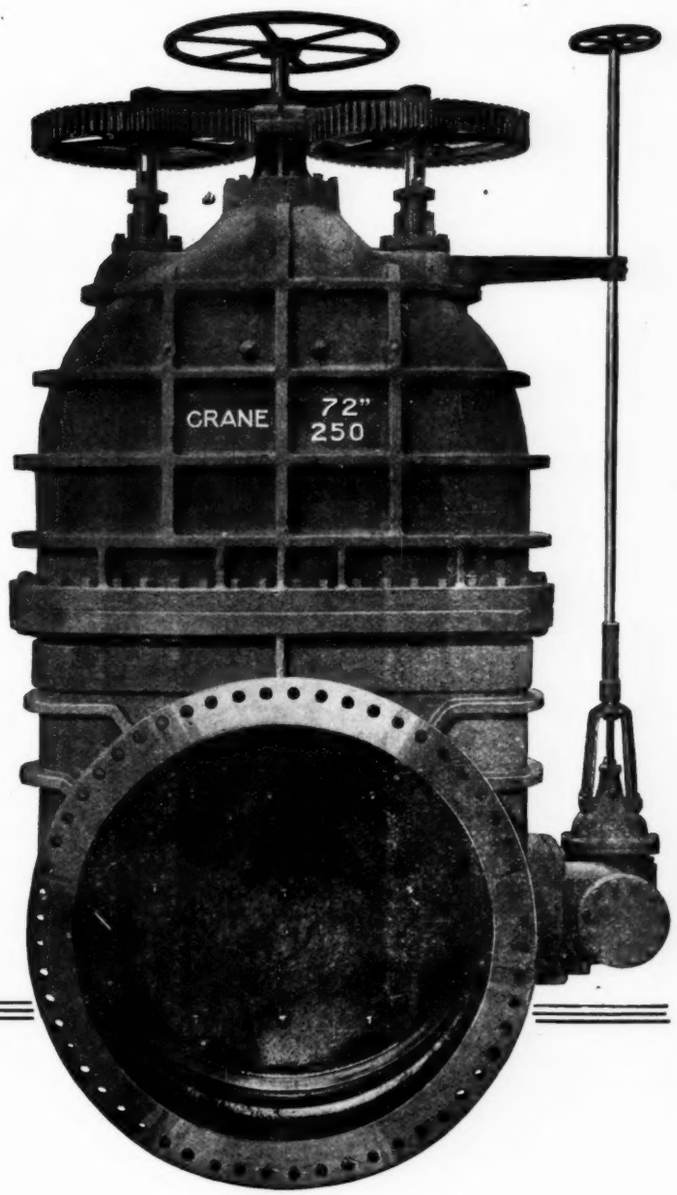

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TABLE II—COMPARATIVE PREWAR AND PRESENT REPRODUCTION COST OF WATER WORKS

Plant	Population Served	Tons of C. I. pipe per 1,000 population	Per Cent. distribution system of total cost to reproduce, prewar	Costs of Reproduction				
				Cost of pipe per ton	Prewar	Cost of pipe per ton	Present	Excess present over prewar
A	92,000	245	58½%	$27.10	$3,700,000	$63.00	$6,400,000	73%
B	8,500	217	79%	29.00	280,000	57.05	503,000	80%
C	10,000	286	61%	28.00	264,000	55.00	444,000	68%
D	12,000	294	77%	28.00	394,000	59.50	689,000	75%
E	25,000	170	66½%	27.10	632,000	68.90	1,192,000	89%
F	25,000	179	46%	27.50	761,000	52.80	1,242,000	63%

With pipe at present price ($66 Birmingham) percentages in last column would be raised to 78% for A, 91% for B, 87% for C, 86% for D, 91% for E, 74% for F.

cent. of the total value prior to the war was in the distribution system, the cost of reproduction at the present time would be approximaely 75 per cent. above prewar.

2nd. For a property in which approximately 75 per cent. of the value was in the distribution system prior to the war, the present cost of reproduction would be approximately double that of the prewar.

Subsequent to the making of these reproduction estimates the costs of lumber, millwork and some other materials have risen which would tend to increase these percentages slightly.

Consideration of Increased Costs Necessary in Valuation

In using reproduction estimates to reason out the valuation of utility properties, several fundamental requirements must be complied with. Among them are:

1st. The kind of service afforded by the utility must be needed by the public in the future.

2nd. The utility being valued must be capable of supplying the service desired, economically, for the present, and be capable of economical enlargment to supply for the future.

3rd. The service must be supplied by the utility at a lower cost than that at which the individual could supply himself with equivalent service.

4th. The public need for the utility in the near future must be a stationary or increasing demand, and not a decreasing one.

When these fundamental conditions are satisfied, a cost of reproduction estimate, carefully made, using the reproduction conditions and prices which will probably prevail during the period of rebuilding and as well continued over a reasonable future period for which the rates are to be in practicable effect, furnishes the best index or measure of the future value of the property and it is to be noticed that it is the future value that we want to know. There is undoubtedly much difference of opinion as to just where the prices of the next few years will fall; however, there cannot be much disagreement with the statement that they will lie somewhere between the prewar normal and the present prices, and the consensus of opinion seems to be that they will lie closer to the present prices than the prewar prices for a considerable time to come.

RESULTS OF PITOMETER SURVEY OF THE EVANSVILLE, IND., WATER SYSTEM

By Charles Streithof, General Superintendent, Department of Water Works, Evansville, Ind.

In August, 1919, after a careful check had been made of the water pumped to the city of Evansville, and of that recorded on over 7,000 meters, including all large consumers, the management of the water department decided to have a survey made of the water distribution system by the Pitometer Company of New York. A preliminary survey was commenced on September 4, 1919.

Method of Making Pitometer Survey

The method of making the Pitometer survey is briefly described as follows: A certain section of the mains is isolated by closing all but one of the boundary valves. A special corporation cock is inserted on the main feeding this district, through the open valve. The main is traversed and the velocity of the water determined by the instrument inserted in the main through the corporation cock. Gaugings are recorded on photo recorders for 48 hours, and from the velocities shown the flow is computed, and as all the water entering this section passes the instrument the amount measured must be the consumption of the district. The interesting feature of these records is the relation between the minimum night rate which is usually found between 11 p. m. and 3 a. m., and the total 24 hour consumption. A high night rate, unless accounted for, means leaky fixtures or breaks in mains. In our case, however, it meant that someone was getting something for nothing.

The night consumption was estimated from 6 p. m. to 6 a. m., and the day consumption was estimated from 6 a. m. to 6 p. m.

Two districts were selected, one in the north end of the city, consisting of 110 city blocks. This district is residential and in it are located twelve manufacturing plants and two packing houses.

District No. 2 is in the heart of the city, where the main piping and surface piping are about 50 years old. This district is composed of 42 city blocks. The district includes a large portion of the business section, hotels, theaters, churches, city hall, police and fire stations, hospitals and clubs, and a great many residences, of which only a few are metered.

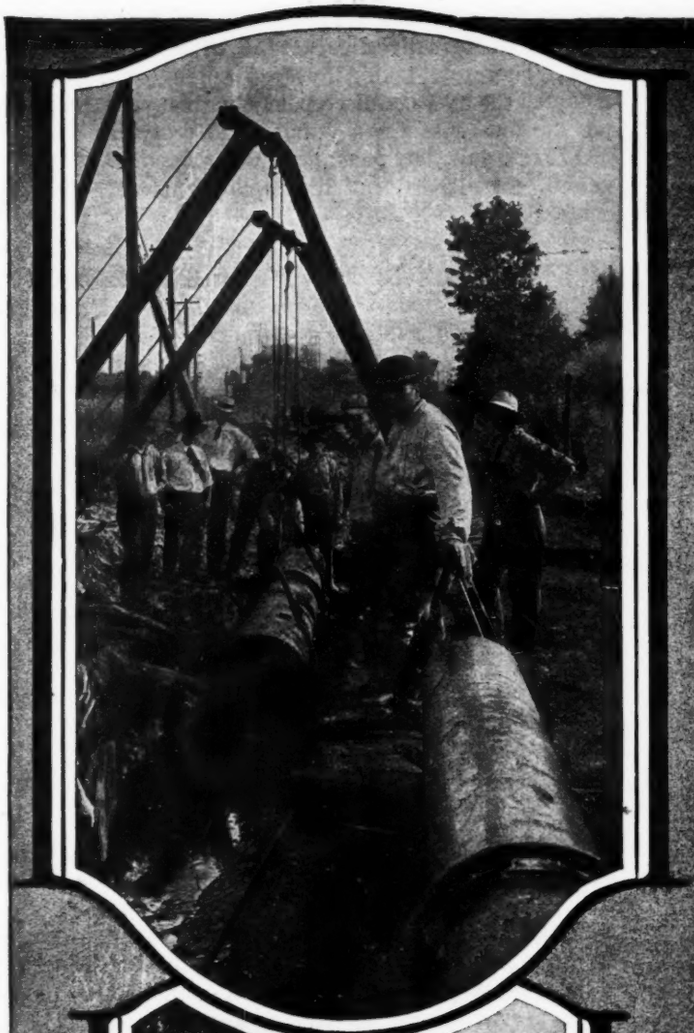
Pump Slippage

A 24 hour measurement of the flow of water was made on the two 30-in. mains supplying the distribution system, as near to the pumping station as practical, in order to obtain a total consumption and also test the pumps for slippage.

The results of the tests for slippage were as follows:

Discharge by pump counters..10,245,600 gals. per 24 hrs.
Pitometer measurement .....10,102,000 gals. per 24 hrs.
Slippage ..... 143,600 gals. per 24 hrs.

From the above figures it will be noted that the slip on the pumps was less than 1½ per cent.



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Results of Preliminary Survey

District No. 1 was isolated by closing all valves excepting one 12-in. valve. This line runs near all the manufacturing plants, and the results of the tests were as follows:

Average daily consumption.....1,018,000 gals.
Minimum night rate ..... 750,000 gals.
Per cent. of night rate to day rate..... 73.6%

The results of our test were as follows:

350,000 gals. per day in the 12-in. main on Morgan Ave.;

175,000 gals. per day distributed through 110 blocks of 6-in. and 24-in. mains in the remainder of the district.

The 350,000 gals. per day on Morgan Ave. were accounted for as follows:

129,000 gals. per day industrial use, metered;

36,000 gals. per day Evansville Packing Co., 6-in. meter;

185,000 gals. per day Evansville Packing Co. passing through the above 6-in. meter but not being recorded.

Meter Found Not Registering a Large Flow

Three different tests were made at this plant at different times to verify the above results:

Test No. 1: Pitometer showed 231,000 gals. per day passing through main; meter showed 46,000 gals. per day passing through main; discrepancy, 185,000 gals per day.

Test No. 2: By closing the valve on the 6-in. supply to meter, pitometer showed 214,000 gals. per day passing through main; meter showed 41,000 gals. per days passing through main; discrepancy, 173,000 gals. per day.

Test No. 3: Pitometer gauging point at the meter, pitometer showed 242,000 gals. per day passing through main; meter showed 64,000 gals. per day passing through main; discrepancy, 178,000 gals. per day.

Result of Test No. 1: While the pitometer showed that water was flowing into the plant at the rate of 444,000 gals. in 24 hours, the meter registered at the rate of 266,000 gals. in 24 hours, or a discrepancy of 178,000 gals. in 24 hours.

Result of Test No. 2: While the pitometer showed that water was flowing into the plant at the rate of 360,000 gals. in 24 hours, the meter registered only 153,000 gals. in 24 hours, or a discrepancy of 207,000 gals. in 24 hours.

The 4-in. meter at the same plant had not registered since the reading taken in October, 1918. The consumption for the last month this meter was in commission was approximtaely 250,000 gals. for the 30 days, or an average of 8,000 gals. per day. We not only know they use water through this main by the pitometer tests, but when their supply was shut off at the main at night, they were compelled to call the department the next morning and ask to have this supply turned on again.

It is difficult to say how long this large meter had been under-registering. We do know that, with the meter still registering, although incorrectly, this loss of water and consequent loss of revenue would have continued for an indefinite period, through no fault of the meter reader.

After a series of tests on this meter it was inspected by two meter representatives, and it was found that the gear ratio on the low side of the meter was wrong. At the time of their investigation the meter was 45 per cent. slow. Therefore, taking a very low figure of 175,000 gals. a day as the average discrepancy at this plant, and figuring the total loss for a year, would represent a loss of 63,875,000 gals. At 5 cts. per 1,000 gals. the loss in revenue to the department was approximately $3,200 per annum.

District No. 2 is, as explained heretofore, in the heart of the city. This district was isolated by closing all the valves of the boundary line, and feeding water through a 12-in. line which is located in the center of the district. A gauging point was established at the west end of the district. The results of this test were as follows:

Average daily consumption.....1,043,000 gals.
Minimum night rate ..... 700,000 gals.
Per cent. of night rate to day rate..... 67%

On further investigation the following leaks were located:

A 1-in. connection discharging into an abandoned vault; and three 1-in. services broken off at the mains discharging into sewers.

This ended the preliminary survey. As the results obtained were sufficient to warrant the survey of the entire city, the management of the department entered into a contract with the Pitometer Company for a survey of the entire distribution system of the water department.

Survey of Entire City

The city was now divided into 15 districts, and these districts again sub-divided into two, three or more sub-districts, depending upon the extent of the territory to be closed in. In all districts where gauging points were established for sub-division work a permanent vault was built, covered with an iron manhole, so that at any time in the future tests may be made, without again tearing up the paving. Traverses were made at all gauging points on mains larger than 6 ins. in diameter.

It may be of interest to know that, in a district which is 100 per cent. metered and entirely residential, an average daily consumption was 153,000 gals.; a minimum night rate of 115,000 gals. The per cent. of the night rate to the day rate was 75 per cent. This district was composed of 56 city blocks, all thickly settled.

The results of the test showed that 36,000 gals. were running to waste at a public school building, where the following fixtures were found to be running continuously, night and day: 30 toilets, 14 urinals, 4 drinking fountains, 7 wash stands.

The balance of the water was distributed uniformly throughout the rest of the district.

General Results of the Survey

After the surveys of all the districts were made, it was found that water was being wasted in all public buildings, particularly those supplied with water at a minimum rate, or those who are getting water gratis. Sixty-nine house service connections were found with bad leaks, or broken service connections discharging into sewers. One drain line valve was found partly open. Three fire hydrants were found with drain valves disconnected and water discharging into sewers. Several unauthorized connections were also discovered.

Since the completion of the survey a comparison has been made of the average daily pumpage, showing a reduction of 669,000 gals.

Notwithstanding that the system is 50 per cent. metered, including all large services, and that every manufacturing plant and other industry in the city is working full time and overtime, and that 900 additional services have been added, we think that this service was well worth the money expended for it. By making this survey practically all the valves in the distribution system were operated, and in several instances it was found that pipe lines were not connected, of which the department had no information. All fire services were tested, unknown to the owners. Several illegal connections were found.

Sometime after the discovery of the discrepancy in the large meter the manufacturers made a report, from which we quote as follows: "The 6-in. meter purchased from us some three years ago was shipped from our factory to Evansville, Ind., with a cubic foot register. This was replaced with a gallon register, and change gears shipped from our branch office for making this change. The branch office made a mistake in the change gears, sending register 36 S V 20 in place of register gear 33, and stuffing box gear 33. I changed these gears and had the Pitometer man check the registration. Mr. Streithof witnessed this test, the error being about 45 per cent."

The underground leakage located during the survey amounts to over 500,000 gals. per day, which, at a rate of 5 cts. per 1,000 gals. per day would indicate a saving of $25 per day. This amount does not include the under-registration of meters.

This paper by Mr. Streithof was presented at the annual meeting of the Indiana Sanitary and Water Supply Association.

MUNICIPAL OWNERSHIP OF GAS PLANT AT OMAHA, NEB.

Omaha, Nebraska, with a population of about 200,000, is the largest municipality to acquire municipal ownership of the gas plant. The question of municipal ownership of the gas plant has been under consideration since November, 1907, when a special election was called to sumbit to the public the question of voting bonds in the amount of $3,500,000. This election was defeated, but again in May, 1918, the proposition of acquiring the gas plant by exercise of eminent domain through condemnation court was carried. The city of Omaha and the company had appraisals made which were submitted to the condemnation court. The company had three separate appraisals made and the city had the property appraised by Burns & McDonnell, consulting engineers, of Kansas City, Missouri. The four values placed upon the property were as follows:

Burns & McDonnell, representing the city..	$3,760,000.00
W. H. Taylor, representing the company...	6,281,000.00
H. C. Anderson, representing the company..	5,518,000.00
Wm. A. Baehr, representing the company..	5,570,000.00

The above figures represent the depreciated values of the property and include going value. Early in February, 1920, the condemnation court rendered a decision awarding the gas company $4,500,000 as the value of the property, and on March 20, 1920, the city commissioners voted to take over the gas works and its operation at the price of $4,500,000. The city commissioners further voted $1,000,000 as working capital for improvements and extensions.

The appraisal and hearing before the condemnation court has required approximately one year's time, and thirteen years after the original proceedings were started the city of Omaha came into possession of the gas plant, and it will be operated by the municipality under a bipartisan board of directors with a manager in charge of the property. It is anticipated that under the city management the rates will not be increased as has been recently the case with many privately owned and operated gas plants. The same board that now so successfully operates the municipal water plant will operate the gas plant.

HIGH EFFICIENCY CENTRIFUGAL PUMPS

In a pamphlet entitled "High Efficiency Centrifugal Pumps," the De Laval Steam Turbine Co., of Trenton, N. J., has described official tests made by the city of Minneapolis upon a 20-in. De Laval centrifugal pump driven by an induction motor and similar tests made by the city of St. Paul upon two 12-in. De Laval centrifugal pumps driven by synchronous motors. The Minneapolis pump, which discharges 30,000,000 gals. per day against a head of 251.56 ft. showed a combined efficiency of motor and pump of approximately 82½ per cent. and a pump efficiency of 86 per cent. The smaller St. Paul units, pumping against heads up to 185 ft. showed over all efficiencies, including pump and motor, of 78 and 78.4 per cent. respectively and pump efficiencies of 81.8 and 82.2 per cent. These performances, together with favorable contracts for electric power, have resulted in remarkably low costs for pumping water in each instance. This publication should be of interest to all who are concerned with the handling of water by electric power.

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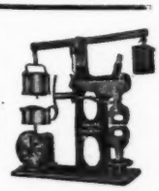

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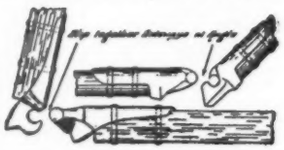

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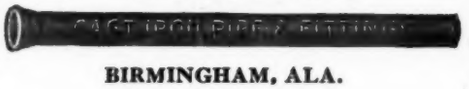

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Construction News and Equipment

CONSTRUCTING CONCRETE ROADS IN NEBRASKA

The road-making material pumped up from the Platte river, in Nebraska, has several characteristics which have heretofore caused engineers to be skeptical about the advisability of using it for concrete paving. That the material may be suitable for this purpose after all is explained in a recent monthly report of the Nebraska Department of Public Works.

A sample of the material was sent to the testing laboratory of the Bureau of Roads, Department of Agriculture, Washington, D. C., to determine whether the so-called Platte river gravel would meet their approval and whether it could be used for concrete paving work in Nebraska. As a result of this testing it was decided to use this material for concrete paving a portion of the Lincoln Highway, 5.94 miles in length, running from Fremont to Ames. This matter was an important one, as it meant utilizing the greatest supply the State has for paved roads.

New Features a Departure from Ordinary Methods

The Platte river runs parallel to this road, and material for the aggregate could be obtained within very reasonable hauls direct from the plants operating along the river in the immediate vicinity of the road. The feature of this road that makes it different from the ordinary construction of concrete roads is as follows:

First. The aggregates used are such a radical departure from the ordinary accepted practice as to excite considerable interest.

Second. The construction methods, while not original, are interesting, owing to the fact that labor has been reduced to a minimum by the installation of the very latest machinery. In this connection it might be well to state that the effluent of the pump dredge carries the sand and gravel to a system of sorting screens and chutes, where the fine and waste materials are returned to the lake pit. The material to be used is delivered into the bins ready for truck loading. The material then hauled to the piles, located at convenient places, and hauling from bins to the stock pile is done by trucks.

Handling Materials Direct by Trucks Eliminates Team Question

Near these stock piles a platform for the storing of cement bags has been erected, and all of the charges for the mixture are carried from the stock piles by means of light capacity trucks. These light trucks are equipped with Lee dump bodies holding 21 cu. ft. They receive a charge of five sacks of cement to 15 cu. ft. of sand-gravel mixture. The sand-gravel mixture is loaded on the trucks by means of an automatic loader. This charge is rushed to the mixer, dumped and the truck returns for another load. The advantages of this manner of handling material from the stock piles to the mixer over the old method of hauling by teams are as follows:

First, the sub-grade is kept in good condition ahead of the concrete. The stock is not stored between the forms, and the action of the oversized tires of the trucks tend to smooth up the sub-grade.

Second. The speed of operation of the truck avoids the confusion and congestion that occur with teams, as many teams must be on the road to handle the same amount of material.

Third. It eliminates the old-time skinner, who sleepily dozed over a pair of mules, and utilizes the young man who is wrapped up in motor vehicles, encouraging him to work at something that he really likes, thus helping to solve, in a measure, the labor problem.

Fourth. Above all, it greatly diminishes the number of men required, and entirely eliminates the team question.

Concrete is mixed in a large ¾ yd. Foote concrete mixer, which is equipped with caterpillar tractors. It distributes the load of the mixer on the sub-grade at a pressure of about 4½ lbs. per square inch.

The ease with which the machine can be moved forward with little damage to the sub-grade makes it an ideal machine for concrete paving. The forms used are Blaw Knox pressed steel, and combine the qualities of a form with a track to receive the finishing machine. The finishing machine used is manufactured by the Lakewood Engineering Co., and is both a money-saver to the contractor as well as a source of satisfaction to the engineer.

No Economy in Building Roads with Antiquated Machinery

This finishing machine automatically cuts out the finished section of the road by means of a steel template attached to the front of the machine. A short distance back of this template is a curved tamper that tamps the road evenly to the exact finished cross section. A belt is mounted behind the machine that rapidly passes back and forth across the pavement, and puts a finish on work that cannot be equaled by hand. The whole machine is motor-driven, and when once started needs no attention except to stop it. Such machinery is a time and labor-saving device, and is one method of building roads economically. It is not economical to build roads with antiquated machinery.

Laboratory Established in Field to Test Materials

The cement is tested, according to the methods of the American Society for Testing Materials, in a laboratory which was established and equipped for that purpose in the field. Sieve analyses are made of the sand-gravel aggregate from time to time. Very close watch is kept on this material to see that it conforms exactly with the specifications. Little variation of the coarser material is allowed, and any deficiency in this respect has to be supplied.

Construction Work Carefully Supervised

The work is supervised by the Nebraska Department of Public Works, aided by the federal government. The State places a project engineer on the work, who is re-

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quired to lay out the work, secure samples of the materials and be responsible for the inspection of the same. He makes a daily report to the department of the materials used and progress made. He is also subject to inspection from the officials of the United States Department of Agriculture, Bureau of Roads, and the state department.

Question of Cheaper Pavements Rests on the Results of This Work

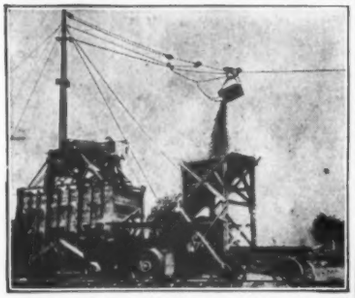
Although this work represents only a small portion of Nebraska's road building program, it is being watched by engineers throughout the Middle West with a great deal of interest, for on the result of this work rests the question of cheaper pavements for some of the Central Western states that have no suitable material for coarse and fine aggregate. The successful use of the Platte river deposit will have a great influence in extending hard surface road systems in Nebraska and adjoining regions.

LIST OF CONSTRUCTION EQUIPMENT USED ON FIFTEEN CONCRETE ROAD JOBS IN ILLINOIS

The present article gives a list of the construction equipment used on 15 contracts for the construction of concrete roads in District No. 1 of the Division of Highways of the Department of Public Works and Buildings of the State of Illinois. Mr. G. N. Lamb is District Engineer. The article gives the equipment used in the month of August, 1919.

James O. Heyworth had the contract for sections 4, 5, 6 and 7, in Kane and DeKalb Counties. The water supply was through 35,000 ft. of 2½-in. pipe. There were 3 Novo 6-h.p. pumps. The concrete equipment consisted of 2 Lakewood finishing machines, 2 Koehring 4-bag concrete mixers and 5,280 ft. of Blaw forms. The storage bins for sand and stone each contained 80 cu. y'ds. and the cement bins held 610 bbls. Each bin dumped 10 batches simultaneously. There was one steam-driven locomotive crane of 20-ton capacity, equipped with a 1½-cu. yd. clam-shell bucket. Two small derricks were operated by steam on the mixer. Five Whitcomb locomotives from 6 to 28 tons in size, with gasoline power, were used. There were 100 Western tram cars; 200 Western batch boxes of 0.82 cu. yd. capacity, filled with a spout and emptied with a derrick. The industrial track was 30,000 ft. long, with 7 ties to 15 ft., and of 24-in. gage. There were only 5 wheelbarrows on the job. For subgrade equipment 2 Carr subgrade machines were used and 2 gasoline-driven Austin rollers of 10 tons size. The miscellaneous equipment consisted of 1 elevating grader, 2 5-ft. Fresnos, 4 slips, 4 plows, 6 wheel slips, 2 complete camps and 2 complete blacksmith shops.

The Illinois Hydraulic Stone & Construction Company were contractors on section 3 in Du Page County. The water supply was obtained through 10,000 ft. of 2-in. pipe pumped by 1 lift and 1 force pump of 2 and 4-h.p., respectively. One Lakewood finishing machine was used. There were 2 concrete mixers, one of Koehring and the other of Smith manufacture, of 2 bag and 1 bag capacity, respectively. There were 1,000 ft. of Heltzel forms.



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Remember also that a Sauerman Dragline Cableway Excavator is especially economical and efficient for digging sand and gravel from under water, as witness its frequent use instead of a pump or dredge.
For a specific recommendation on equipment suitable for your operations, write us in detail about your ground conditions, daily output wanted and other requirements of your proposition and we will give you our frank advice.
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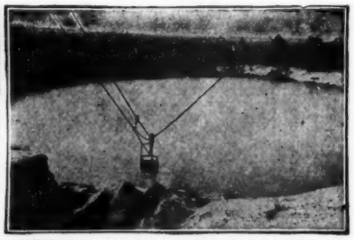
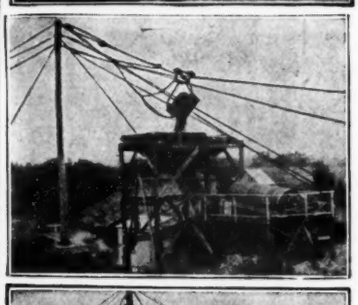

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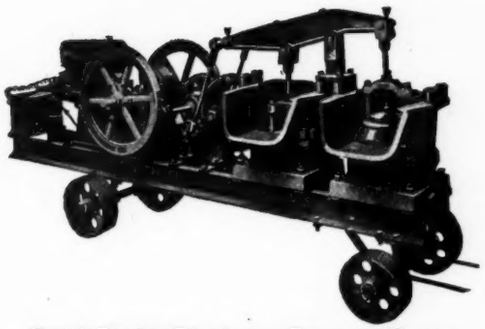
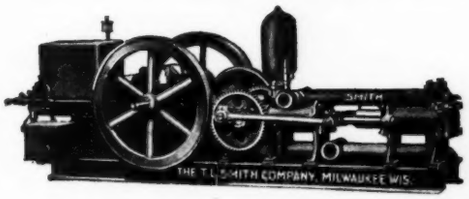


Smith Double Diaphragm Pump on Trucks



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The pump is a vital factor in most construction jobs. Smith pumps are of proven efficiency. You can depend on them. Don't take any "just as good" substitute. Saving a few dollars on initial cost may kill the entire profits on a job by putting 30 or 40 men "down" because of pump failure.

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Write for Bulletin entitled "NEVER FAILING WATER." It not only contains complete details on Smith Pumps, but gives valuable data on correct sizes of pipes to be used with various pumps, friction tables, etc., which are of inestimable value to every contractor.

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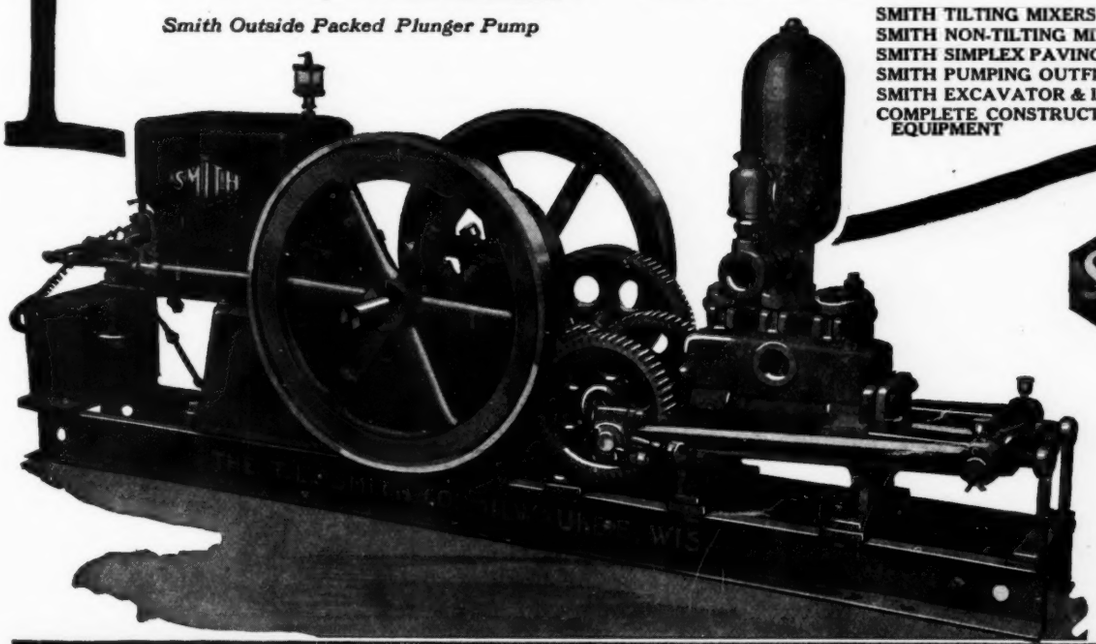


Smith Double Acting Force Pump

SMITH

SMITH PUMPS

Sand and stone bins each had 90 cu. yds. capacity. Cement was handled in sacks. Home made batch boxes holding 0.4 cu. yds. and numbering 160 were used. They were filled from an overhead hopper and emptied by overturning. Two Holt tractors of 75 and 100 h.p. were used and also one 2½-ton Sandow motor truck was used; also 16 6-ton Troy trailers. One 10-ton, steam, Buffalo-Pitts roller was used on the subgrade. Miscellaneous equipment consisted of 2 slips, 2 wheelers, 3 Fresnos and 2 plows.

The R. F. Conway Company had the contract for sections B, C and D in Will and Cook Counties. Water supply was through 31,600 ft. of 2½-in. pipe and there were five 7-h.p. Gould centrifugal pumps. Three Lakewood finishing machines were used. There were four 4 bag Foote concrete mixers and 8,000 ft. of Blaw forms. One ¾-yd. steam derrick was used. A 55-h.p. Holt tractor was used and 12 motor trucks ranging from 1 to 8 tons capacity and consisted of 5 Macks, 2 Overlands, 3 Whites, 1 Garford and 1 Diamond T. A total of 48 wheelbarrows were used, and two 12-ton steam Castler road rollers. There was also one ¾-yd. Thew steam shovel, 1 Austin grader, 12 wheelers, 12 slips and 12 dump wagons.

F. Lorenz had section 55 in Cook County. The water supply was through 6,600 ft. of 2-in. pipe with one 6-h.p. Olds pump. The mixer was of Ransome make of 1 bag capacity and 500 ft. of wood forms were used. One 1½-ton Ford truck and 5 wheelbarrows completed the equipment on this job.

Blase & Gerken had section 63 in Cook County and obtained water from a city plug. They used wood forms and a 2-bag Ransome mixer. Hauling on this job was let to a sub-contractor and 5 wheelbarrows completed the general contractors' equipment.

Chicago Heights Coal Company had sections 8, 9, 10 and H-15d on the Dixie highway. Water supply was through 15,000 ft. of 2-in. pipe with a 7-h.p. C. H. & E. pump. Concrete equipment consisted of 1 Lakewood finishing machine, one 3-bag Koehring mixer and 1,000 ft. of Lakewood forms. There were seven 3-ton Autocar trucks. On the subgrade 2 rollers were used of Kelly-Springfield and Buffalo-Pitts manufacture. Miscellaneous equipment consisted of 12 teams, 1 Lee loader, 2 graders, 8 wheelers, one ¾-yd. Thew steam shovel and 3 small mixers.

Hart & Page had sections 18, 8 and G in De Kalb County. Water supply was through 16,000 ft. of 2-in. pipe with a 20-h.p. Fairbanks-Morse Company pump in conjunction with a pressure tank. Concrete equipment consisted of 1 Lakewood finishing machine, one 4-bag Koehring mixer and 1,800 ft. of Heltzel forms. There were two 1-cu.-yd. hoppers; 1 Erie steam locomotive crane of 13-ton capacity, with ½-yd. clam-shell bucket was used. One 15-h.p. International Harvester Company tractor was used and 6 motor trucks, 5 called "Government" trucks and 1 Packard. Thirteen wheelbarrows completed the equipment.

Cole & Fauber had the contract on sections K and L in McHenry County. Water supply was through 2,500 ft. of 1½-in. pipe in a 2½-h.p. Foos pump. The mixer was a Ransome of 1-bag capacity and 1,000 ft. of wood forms were used. The locomotive crane was of Keystone manufacture, steam-driven, 20-h.p., equipped with No. 3 clam-shell bucket. Four Nash-Quad trucks were used and 10 wheelbarrows.

Powers-Thompson Company had section A in Cook County. Water supply was through 1,400 ft. of 1½-in. pipe and 5,000 ft. of 2-in. pipe with 1 Deane pump and 1 Fairbanks-Morse Co. pump. Concrete equipment consisted of 1 Lakewood finishing machine, one 3-bag Koehring mixer and 900 ft. of Blaw forms. Four motor trucks from 2½ to 5-ton capacity were used, 2 being Republics and the other 2 Garfords. On the subgrade one 10-ton steam Huber roller was used. An Austin grader and 12 wheelbarrows completed the equipment.

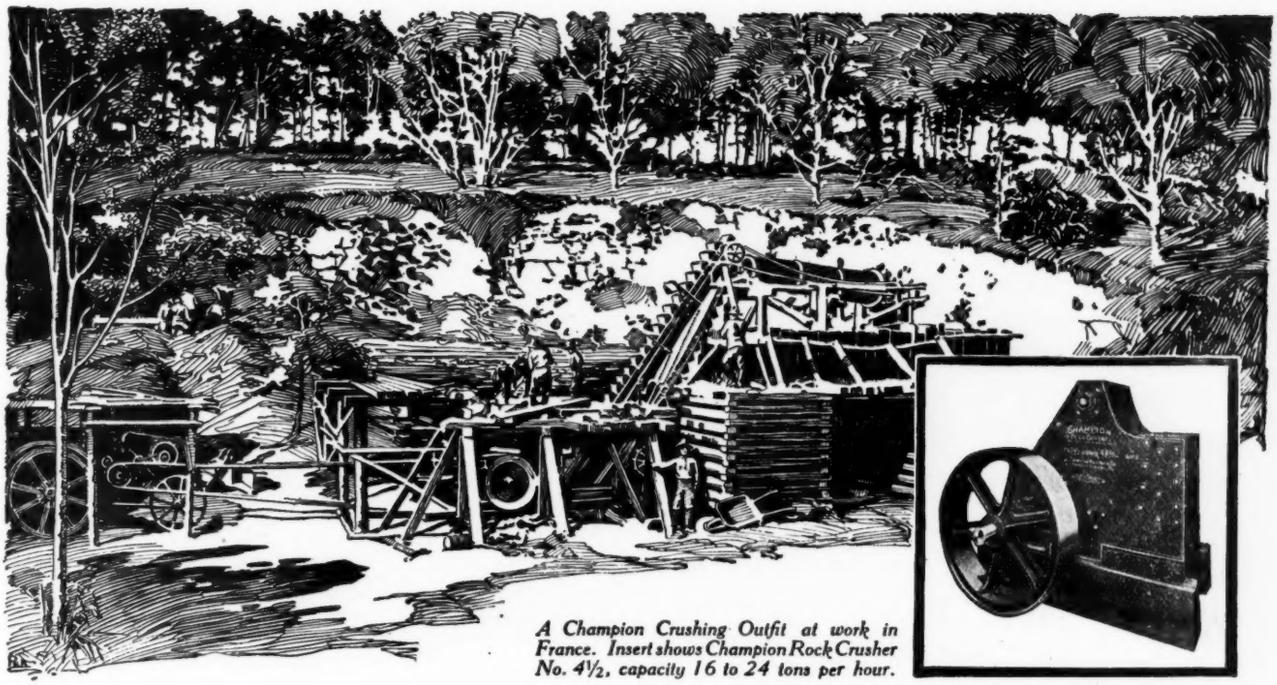
Powers-Thompson Company also had section G in Will County and obtained the water supply from a city plug through 11,000 ft. of 2-in. pipe. The mixer was a Koehring of 3-bag capacity and 2,000 feet of wood forms were used. On this job material was delivered along the road by an interurban railroad. Other equipment consisted of one 10-ton Huber steam roller, 6 material carts, a plow, a scarifier and a grader.

Calumet Construction Company had sections 1, 2 and G-29-a in Du Page County. Water supply was through 13,000 ft. of 2-in. pipe with one 7-ton h.p. Smith pump. Concrete equipment consisted of 1 Lakewood finishing machine, one 5-bag Austin mixer and 3,000 ft. of Heltzel forms. Storage piles were used, the sand pile containing 1,000 yds, the stone 1,600 yds. and cement 3,000 barrels. One Erie 20-h.p. steam locomotive crane of ¾ cu. yd. size was used. There were two 6-ton Koppel locomotives and 60 Koppel tramcars; also 100 1-yd. Koppel batch boxes filled by gravity and emptied by the crane on the mixer. The industrial track was of 24-in. gauge and 5 miles in length. Three Holt tractors were used and 3 motor trucks of Mack and Republic manufacture.

The Mellen-Stuart-Nelson Company had sections 50 and 51 in Cook County. Two pumps were used, one of Fairbanks-Morse manufacture and the other of Domestic Engr. Co. make. Concrete equipment consisted of 2 Lakewood finishing machines, two 4-bag Koehring mixers and 3,000 ft. of Blaw forms. Storage bins were provided of 120 cu. yds. capacity for sand and stone and 120 barrels of cement. Two locomotive cranes equipped with 1½-yd. clam-shell buckets were used, 1 a Mundy and the other a Flory. Six industrial locomotives were used, 2 Whitcombs and 4 Plymouths; also 60 Western tram-cars and 120 Western batch boxes of 32 cu. ft. capacity filled by gravity and emptied through bottom dump. The industrial track was 24-in. gauge and 4 miles long. One 75-h.p. Holt tractor was used on this job and 1 Carr subgrade machine; also two 10-ton Austin kerosene burning road rollers. Miscellaneous equipment consisted of 1 Austin scarifier, 3 Maywood scrapers, 6 wheel scrapers, 6 Fresnos, 2 Western plows and 2 No. 6 Western plows.

The Commonwealth Improvement Company had the contract on Higgins Road in Cook County. Water supply was through 15,000 ft. of 2-in. pipe with 1 Fairbanks-Morse, 1 Novo and 1 Domestic pump and 2 steel tanks. Concrete equipment consisted of 2 Lakewood finishing machines, 2 Marsh-Capron and 1 Austin mixer all of 4-bag capacity and Heltzel forms. One small mixer, 2 Barber-Greene wheelbarrow loaders, 1 Lidgerwood hoist and 1 No. 10 rock crusher with screens and bins, completed the equipment.

The Eclipse Construction Company were contractors on



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The GOOD ROADS Machinery Co., Inc.

section 58 in Cook County. Water supply was through 10,000 ft. of 2-in. pipe with one 2½-h.p. Goulds pump and one 6-h.p. Barnes pump. Concrete equipment consisted of 1 Lakewood finishing machine, and one 4-bag M-C mixer and a small mixer for culverts; also 800 ft. of Blaw forms. On the subgrade one 12-ton gasoline Austin roller was used; 15 wheelbarrows completed the equipment.

Paschen Brothers had the contract for sections H and 15d in Lake County. Four Novo pumps were used on the water supply. Concrete equipment consisted of 1 Lakewood finishing machine and 3 M-C mixers and 2,500 ft. of Blaw forms. Two locomotive cranes equipped with a ¾-yd. clam shell bucket were used; also 3 Clark motor trucks. One 10-ton Austin steam road roller was used on the subgrade. Miscellaneous equipment consisted of 1 Austin scarifier, 2 conveyors and 6 dump cars.

SHORT CUT METHOD OF HANDLING MIXED AGGREGATE TO PAVING MIXER

Considerable interest has been manifested among road builders in the success of the Charles Connor Construction Co., of Denver, in the use of a short cut method of handling the mixed aggregate to feed the paving mixer.

The job under consideration entailed the laying of 26,000 sq. yds. of 6-in. standard reinforced pavement on the principal thoroughfare of Thermopolis, Wyo., probably the first paving work ever done in the Big Horn Valley.

Stationary bins were placed under a screening plant located at the gravel pit about three-fourths of a mile from the job, from which sand and pebbles were mechanically loaded through spouts into three 3½-ton and one 5-ton White trucks. These were fitted up with three and six compartments, respectively, each carrying 6 cu. ft. of sand and 9 cu. ft. of pebbles, the required amount of separated material for a three-sack batch. These aggregates were hauled direct to the mixer and dumped into

WHITE TRUCKS WITH COMPARTMENT BODIES DUMPING AGGREGATE DIRECT INTO LOADING SKIP OF SMITH PAVER.

the skip by releasing gates at the rear end of each double compartment and hinged at the top. The cement was added to the batch in the skip by hand.

This method of handling the aggregate insured a continuously uniform sized batch and with a considerable saving of both time and labor, the latter of which is a particularly important item at this time. The cost of the entire work of rehandling the material between the screening plant and mixer is estimated at $80 per day.

The paving was done with a Smith paver with a rotary distributing boom, the mixer having a capacity of 14 cu.

GRAVEL PIT SHOWING SCREENING PLANT OVER LOADING BINS.

ft. of mixed material per batch. This paver is over seven years of age and has been in practically continuous operation all of the time.

The surface of the pavement was finished by roller and belt and protected for 14 days by a covering of 2 ins. of moist earth. Standard ¼-in. premolded joints were placed every 30 ft.

So thoroughly do those interested approve of the results already secured from this initial paving project in Thermopolis that a petition has been successfully circulated for a new district involving six blocks and another for eight blocks.

READY BUILT OR LUMBER FRAMES FOR CULVERTS?

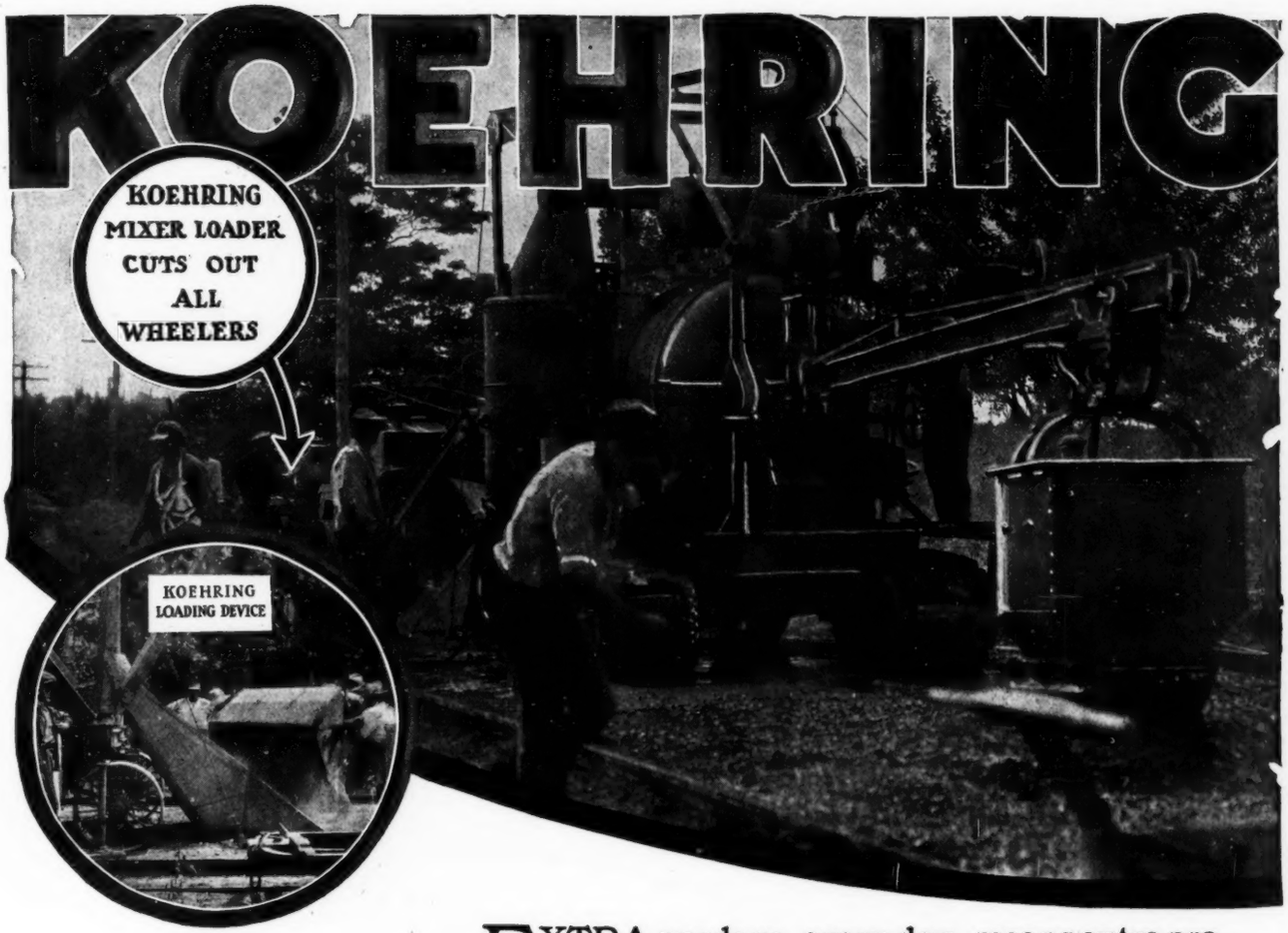
As an element in cutting the cost of concrete culverts, highway engineers and contractors will find interest in the following figures:

Based on the method employed by a highway engineer whose services are in much demand, it requires 29 ft. of 2-in. lumber to build the bracing for a 2 ft. by 2 ft. culvert, worth at present lumber prices about $3. Figuring that it takes three men two hours at 40 cts. per hour to put the lumber bracing for a culvert of this size in place, a labor cost of $2.40 is represented in putting the bracing in place. It takes one man probably two hours, or a labor cost of 80 cts., to knock out the lumber bracing when the culvert is finished. Thus the bracing for every culvert of this size represents a labor cost of $3.20.

For every different size of culvert new lumber must be bought and every set of lumber bracing requires replacing after being used on an average of five times.

A set of ready built steel culvert frames of the type here shown, can be set up in probably ten minutes, as they do not come apart and consequently require no putting together each time they are used. A simple pull collapses them and the lumber used with this frame not being nailed, it drops away undamaged when the frame is collapsed. Thus the culvert can be cleared in much less time than it takes to knock out lumber bracing and a large portion of the labor cost of lumber bracing is saved by this type of ready bracing.

KOEHRING

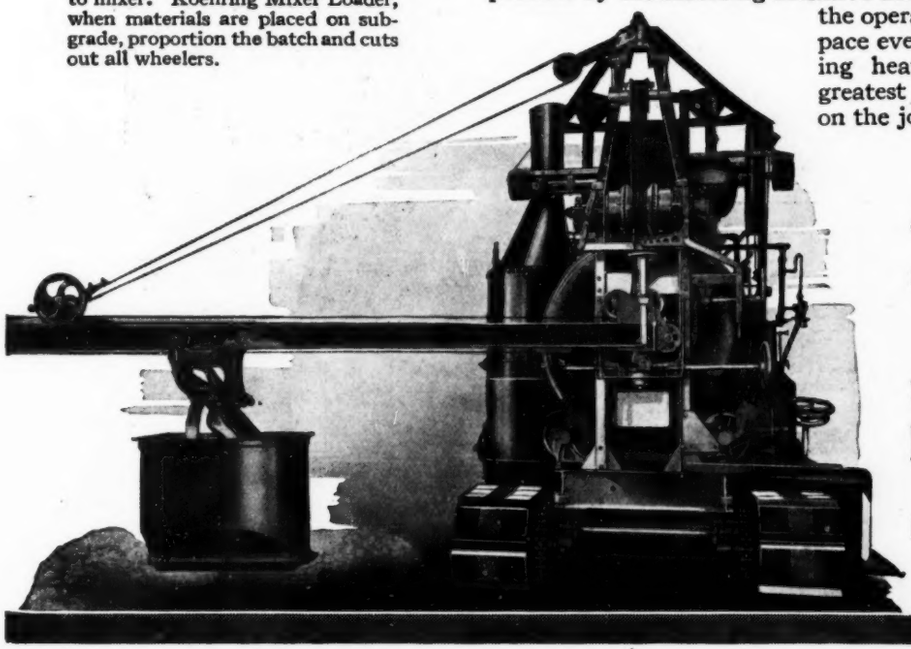


Koehring loading derrick part of Koehring mixer equipment when batches are made up at central loading station and brought to mixer in batch boxes on industrial cars and trucks.

Long narrow design of Koehring Pavers gives extra room on subgrade to bring industrial car close to mixer. Koehring Mixer Loader, when materials are placed on subgrade, proportion the batch and cuts out all wheelers.

EXTRA yardage, every day, means extra profit—because the Koehring is the fastest paving unit—the mixer of liberal drum dimensions, fast loading and discharging, and with Koehring boom and bucket, the fastest distributor of any consistency of concrete.

It's the fastest paving **unit** because these fast operations are made possible by the Koehring exclusive automatic actions which enable the operator to keep up the high speed pace every minute of the day. Koehring heavy duty construction is the greatest profit-insurance you can put on the job.



KOEHRING SIZES

In cubic feet mixed concrete

Construction Mixers: 4, 7, 10, 14, 21, 28, Steam and Gasoline.

Paving Mixers: 10, 14, 21, 28. Boom and Bucket and spout distribution, caterpillar traction, loading derrick, steam and gasoline.

Write for Paver catalog.
Write for Mixer Loader catalog.

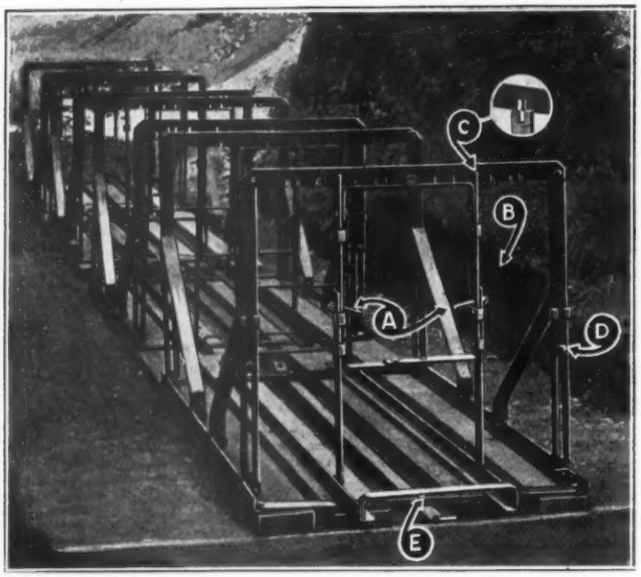
Koehring Machine Company

Milwaukee Wisconsin

Sales and service office in all principal cities.

Being adjustable both in height and width, a set of frames of this type will build a number of different sizes of culverts where lumber bracing, even where it can be torn out in good condition, can be used to build but one size culvert. The steel bracing is good for years of service where lumber bracing needs constant replacing, is another advantage in its favor.

From these figures the highway engineer and contractor can draw very accurate conclusions as to the relative

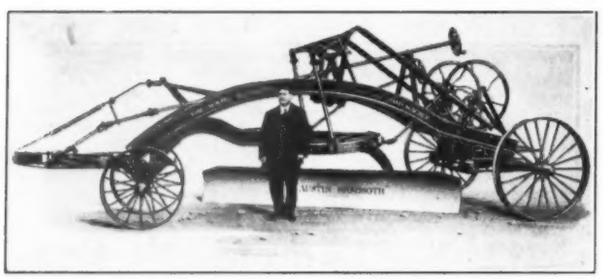


STORMS ONE-MAN COLLAPSIBLE CULVERT FRAMES.

time, labor and material costs of the two methods of culvert construction here discussed. The steel culvert frames used in this comparison are known as the Storms One-Man Collapsible Culvert Frames and are made by the Storms Mfg. Co., Crawfordsville, Ind.

GRADING EARTH ROADS IN NEBRASKA

The shortage of men, materials and machines, which may prevent many of the states from completing their road-building programs for 1920, is being felt in Nebraska as it is elsewhere. As a result the State Highway Department is concentrating considerable of its effort on the construction of earth roads, which later on may be



THE AUSTIN "MAMMOTH" STEEL REVERSIBLE ROAD GRADER AS OPERATED ON NEBRASKA HIGHWAYS.

converted into hard surface roads. This means that even though the mileage of concrete or other hard-surfaced roads built during 1920 may not be great, the State's road program will be going steadily forward. When the time comes for the construction of the hard surface much of the preliminary work will be out of the way.

As part of this program the State has just purchased 70 Mammoth graders from the Austin-Western Road Machinery Company of Chicago. These big machines, weighing 6,350 lbs. each and having 12-ft. blades, will all be delivered in time for the opening of the road construction season. They are being distributed among the majority of Nebraska's 90 counties and are accompanied by heavy tractors.

This buying of graders in wholesale lots is a usual practice and shows the progressiveness of the Nebraska Highway Department.

SMITH DISTRIBUTING BOOM AND BUCKET

An important advantage in the high drum design of paver is presented by the distributing boom-and-bucket on the Smith Simplex. Because of the height of the drum the boom has a clearance of 7 ft. making possible a deep, narrow bucket of ample capacity.

The deep bucket preserves the element of efficiency under all conditions. In discharging any mixture stiffer than a flowing concrete the aggregate has a tendency to pyramid but with this type of deep bucket the mixed material can pile up on a slope of 45 degrees and still the bucket will take the entire batch.

The bucket is equipped with an automatic opening and

SMITH DISTRIBUTING BOOM AND BUCKET.

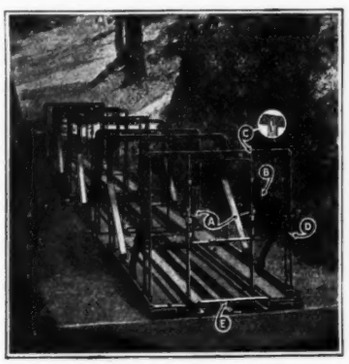
closing device. As it travels out on the I-beam boom, a finger wipes over the contact projections, placed 8 ins. apart, on the under side of the boom. The moment that the direction of the bucket is reversed the finger strikes the nearest contact, trips a toggle lock and opens the bot-

Contractors, Lumber Culvert Bracing Is Too Costly! Here's a Better Way

JOHN H. GORDON
ALBANY, N. Y.
October 7, 1919.

STORMS MANUFACTURING CO.
Crawfordsville, Ind.

Gentlemen:
I am glad to write this letter recommending your Collapsible Forms for use in constructing culverts on State Highway work. They have given us satisfaction, are all that you claim, and have saved us time and money.
Very truly yours.
JOHN H. GORDON.



Here's a ready culvert bracing that's far better than cutting and building a lumber frame that you can use only a few times and for only one size culvert.

Highway engineers and contractors of a dozen states are building their culverts quicker and cheaper with these **adjustable** and **collapsible** culvert frames.

Think! It takes only about ten minutes (against two or three hours for lumber bracing) to put this

STORMS ONE-MAN
Collapsible Culvert Frame

in place and about the same time to clear the culvert when it is finished. Made of **steel,** adjustable in both height and width to different sizes of culverts. Positively guaranteed not to bulge, buckle or sag. Form lumber is **not nailed** and comes away undamaged when frame is collapsed by a simple pull on the tripping rod.

Why waste high-priced labor and lumber? Write **today** for exact cost data showing the saving of using Storms Frames. Ask for "Bulletin M. E. 1." It's free.

STORMS MFG. CO., CRAWFORDSVILLE, INDIANA

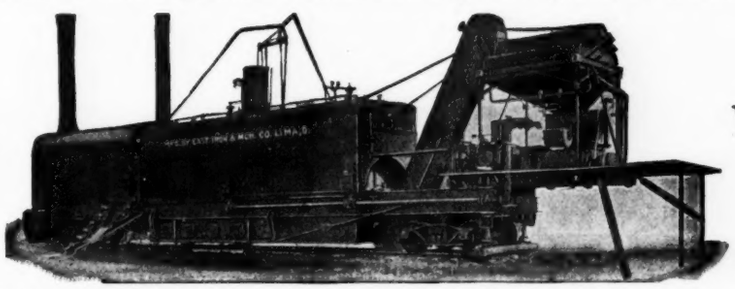
Storms Collapsible-Adjustable Culvert Frames.

Contractors, there is more money for you in the use of the Improved

MERRIMAN ASPHALT PLANT

Because it will handle more asphaltic material than any other plant, do it better, and at less cost.

Helps you to get the better Contracts



Write for capacities and full information

ALL MELTING IS DONE BY STEAM HEAT IN THE MERRIMAN PLANT

Good engineering calls for steam-melted asphalt because this process preserves all the natural oils in the mixture, and consequently produces a live, long-wearing topping, binder, or any other mixture that you might want to use. It is never of the lifeless character so often found when direct fire heat is used. Steam heat, you know, is used in the refining process because it gives the best results. The Merriman Plant carries out the principle.

Steam melting makes it impossible to burn or coke the asphalt. This means a tremendous saving of material—you know what loss burnt batches of asphalt mean.

It also eliminates the possibility of burning the kettle bottoms—another big saving of expense and loss of time when you're busy.

The car measures only 55 feet over all. It is easy to dismantle and set up. Has extra large mixer. Two large melting kettles—a day's run in each. Each unit can be operated separately.

The East Iron & Machine Co., Lima, Ohio, U.S.A.

tom doors. The bucket continues its travel back to the machine, a side roller upon it strikes a stationary guide on the boom, rides upward and closes the door.

These improvements are found on the Smith Simplex Paver, made by the T. L. Smith Co., 472 Old Colony Bldg., Chicago, Ill.

Contracts Awarded

ROADS AND STREETS

Ark., Blytheville—Good Roads Constr. Co., St. Louis, Mo., awarded contract by Miss. Co., Blytheville-Manila-Leachville Hwy. Commrs., Osceola, for construction of 50 miles of road, 17 ft. wide, 7-in. concrete rein., at $1,211,810.

Ark., Helena—Southern Roads Co., Nashville, Tenn., awarded contract to construct 34 miles road from Helena to Marvell; concrete with bitulithic surface, at $1,027,000.

Ark., Mountain Home—Miller Construction Co., Springfield, Mo., awarded contr. by Baxter Co. Road Impvt. Dist. No. 4, for surfacing 11 miles of road from Buffalo to Buford; gravel; 17,326 cu. yds. surfacing; bridges and culverts, $92,000.

Ark., Searcy—Burt Construction Co. awarded contract for constructing road from Searcy to the Prairie County line at Stineville, at $300,000.

Cal., Hanford—C. E. Blanchard, San Francisco, awarded contract for paving Harris, Elm, Myrtle, Katherine and S. Douty Sts. with 4-in. bitum. base and 1½-in. Warrenite surface, at $161,616.

Cal., Martinez—O'Brien Bros., City, awarded contract for paving with conc. 8.48 miles county hwy. betw. here and Hercules, at $178,892; Bates & Borland, Oakland Bank of Savings Bldg., Oakland, awarded contr. for constructing 7.3 miles of road in San Pablo Valley, at $103,784; Geo. W. Cushing, 420 Macdonald Ave., Richmond, awarded contract for constructing 3.2 miles of road betw. Avon and Bay Point, at $65,557.

Cal., Santa Rosa—W. A. Dontanville, Acampo, awarded contract for constr. of 5 miles of concrete hwy. on Sec. A, Petaluma-Sonoma Road, at 90c per cu. yd. for excavation and $105,000 for conc. pavement.

Colo., Pueblo—Strange-McGuire Co. awarded contract for paving North Side District, at $286,660.

Ct., Hartford—C. W. Blakeslee, New Haven, awarded contract for constr. of Hartford-New London Trunk Line, Fed. Aid Project No. 4, at total cost of $1,392,385.

Del., Dover—Field, Barker & Underwood, Philadelphia, awarded contract for 3.43 miles—Mt. Pleasant to Boyd's Corner, at $150,260; Fisher-Corosa Bros., Baltimore, contr. for Neaman's Creek road, 3.36 miles, at $224,336; also road from Hare's Cor. to the Causeway, 4.53 miles, $273,652.

Ga., Adel—Kries & Wardrep, Knoxville, Tenn., awarded contract to pave 8 miles of road on National Highway; Kentucky asph. or Finley method, 16 ft. wide, at $240,000.

Ga., Augusta—Ely Construction Co. and Lawrence Constr. Co. awarded contracts for constr. of 51,525 sq. yds. paving on Stovall, Winter, Wingfield, Heath, Reynolds and other streets; 7,700 lin. ft. granite or conc. curb; $190,000.

Ga., Savannah—Dixon Contracting Co. awarded contract to pave 40,000 sq. yds. streets; vibrolithic conc.; $578,000 available.

Idaho, Boise—Sims & Carlson, Spokane, will be awarded contr. for bldg. 8.4 miles of Clearwater Highway from Greer toward Fraser, if they will consent to alterations in the specfs. to bring cost within appropriation. Price will be about $150,000.

Ia., Garner—Empire Constr. Co., Des Moines, awarded contract for paving 90 blocks here, at $3.56 per sq. yd.—total cost $400,000.

Kans., Fort Scott—Maley & Keleher, Hutchinson, awarded contract for paving Fort Scott-Wichita Road, Bourbon Co., at $108,606.

Kans., Hutchinson—J. H. Shears & Son awarded contract for Avenue B paving, at $146,073.

Mich., Charlotte—F. P. Leonard & Co., Charlotte, awarded contract to build concrete road to extend from Ingham Co. line 6½ miles west to Grand Ledge, at $199,000.

Mich., Jackson—Brooks Constr. Co., Ft. Wayne, Ind., awarded contract for 11 miles sheet asph. paving, 22 miles conc. curb and gutter and 60,000 cu. ft. excav., at $650,000.

Mich., Muskegon—G. P. Scharl, Pontiac, awarded contract for constr. of 14 miles federal aid road in Muskegon county, at $520,365.

Minn., St. James—Johnson, Drake Pipe Co., Minneapolis, awarded contr. for 15 miles of paving at about $500,000.

Miss., Greenville—Brennan & Schevenell, Memphis, awarded contract for concrete street paving here, at $375,000.

Mo., Kansas City—Halpin-Dwyer Constr. Co. awarded contract to pave 2 4-10 miles of road, at $134,495.

Mont., Billings—State Hwy. Constr. Co. awarded contract for Proj. No. 53, Billings-Ballantine road—total 24 miles—at $149,137.

Mont., Helena—Clifton, Applegate & Toole, Spokane, awarded contract for 9½ miles highway from Anaconda to Deer Lodge county line, at $231,678.

Neb., Ord—Allied Contractors, Inc., 304 Bee Bldg., Omaha, awarded contract for paving; 5-in. conc. base with wearing surface of asph. concrete, at $149,079.

Nev., Carson City—Nevada Constr. Co., Hawthorne, awarded contr. for 9 1-3 miles rock cuts and road bldg. on west side of Walker Lake, at $168,889.

N. M., Santa Fe—Mishon, Millard & Teyssier, Pueblo, Colo., awarded contract for constructing 14.37 miles Fed. Aid Rd. Proj. 1-B, at $149,545.

N. C., Asheville—State Hwy. Comm., Raleigh, awarded contract to construct 5¼ miles hard-surfaced road, at $131,222, as follows: Grading, to Asheville Constr. Co., Asheville; surfacing, to H. C. McCraret Co., Knoxville, Tenn.

N. C., Brevard—State Hwy. Comn. let following contracts for constr. of 12 miles of gravel road, at $150,000; grading to Allport Alexander Co., Asheville; surfacing to Asheville Constr. Co., Asheville.

Okla., Marlow—Municipal Excavator Co., Okla. City, awarded contr. for 30,000 sq. yds. asph. conc. paving in business section, at $122,166.

Pa., Butler—Samuel Gamble Co., Carnegie, awarded contract for bldg. 30,180 ft. of road in Adams Twp. and Callery Boro, at $302,047; Burns Brothers, New Castle, awarded contr. for bldg. 18,778 linr. ft. of rd. in Fairview Twp., Karns City Boro, and Petrolia Boro, at $211,684.

Pa., Harrisburg—Dunleavy Brothers, Coatesville, contr. for 19,471 ft. road in Chester and Delaware Counties, extending thru Westtown, Willistown and Edgemont Twps., at $212,850.

Pa., Harrisburg—Following contracts aggregating more than $5,000,000, awarded by State Hwy. Commr. Sadler: Carbon County near Weatherly, 23,420 ft., to Sterling Constr. Co., Lodi, N. J., at $201,334; Delaware Co., Concord Twp., 14,892 ft., to Hayman & Goodman, Jersey City, at $181,737; Greene Co., Jefferson Boro vicinity, 13,811 ft., to Con-Oil Co., Pittsburgh, at $164,444; Northumberland Co. near Elysburg, 11,540 ft., to Fiss & Christian, Shamokin Dam, at $120,349.

Tex., Wichita Falls—Commissioners Wichita County let contract for paving 4.68 miles Hwy. 22, Fed. Aid Project 61, 18 ft. wide, involving 46,448 sq. yds. concrete and 4,358 cu. yds. grading, to Wichita County, care J. P. Jones, Co. Judge, at $182,726.

Va., Norfolk—R. P. Denby awarded contract to construct concrete rd. from Norfolk to Virginia Beach, at $369,000.

Wn., Chehalis—James & Hendricks, Che-

KOLESCH SURVEYING INSTRUMENTS FOR SERVICE

Municipal Engineers!

WE WILL gladly send you one of our instruments to test on your work without any obligation to purchase until it has proved its worth.

KOLESCH Transits and Levels are sturdy, accurate and moderate in price. Every detail has been studied to give an instrument that can be absolutely depended on for unvarying reliability and long life.

The Popular Kolesch "PIONEER" TRANSIT No. 7710.

Send today for Catalog illustrating full line of Engineers' and Draftsmen's Supplies.

KOLESCH & COMPANY

138 Fulton Street, New York City

The Michigan Jr. Gravel Screener and Loader

A Machine that will take the Gravel out of the Pit or Pile, Screen out the Sand and Stones and Load the Gravel into Wagons or Trucks.

The machine runs up and down the side of the pit or pile on a track and takes off a slice of about four feet at each time over the track. After going along the track once, the track is moved over and the loader returned along the side of the pit or pile.

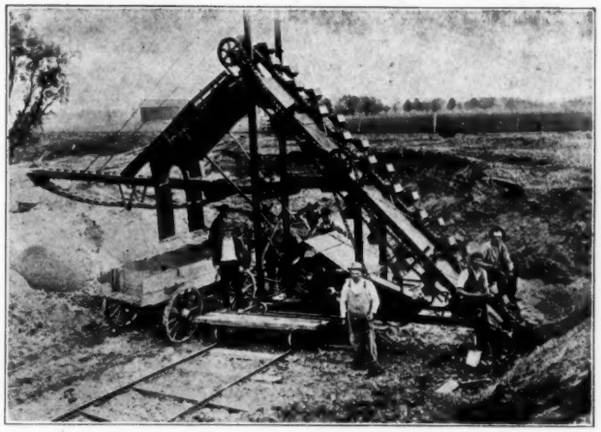
The Screener and Loader is self-contained, furnishing its own power, and has an attachment on the screen that prevents it from clogging up with clay, clods, etc.

The machine has an elevating capacity of *one yard per minute* and, usually, the only operating expense is salary of three men.

One man operates the machine and two men break down the embankment.

The sand and stone are conveyed 20 feet away and do not have to be moved. Machine operates up and down the track as well as in and out of the embankment under its own power. It is all steel, and engine enclosed.

Easily moved from one pit to another. *Saves $30 to $50 per day* in expenses. It is the machine that saves and makes money in handling gravel.



Calhoun County (Michigan) owns and operates four of these machines, and contractors own three others, making seven in the County.

For further particulars write to

THE JORDAN & STEELE MFG. CO., Inc.

CHARLOTTE, MICH.

Full-Revolving, Self-Propelling
LOCOMOTIVE CRANES

Mounted on Traction Road Wheels.
Equipped with 30-ft. Booms and ¾-yard Clamshell Buckets.

ALL BRAND NEW

F. MAYER

53 W. Jackson Blvd. CHICAGO.

CONTRACTORS' EQUIPMENT OF ALL KINDS

halis, awarded contract for paving Winlock-Cowlitz road, at $182,288.

Wn., Colfax—Highway Construction Co., Colfax, awarded contract for construction of 15.2 miles highway betw. Colfax and Endicott, at $138,593.

W. Va., Buckhannon—Edw. J. Knipfle & Sons awarded contract to constr. 5.4 miles concrete pavements on streets and roads leading from city, at $260,000.

SEWERAGE AND SEWAGE TREATMENT

Cal., Bakersfield—Valley Construction Co. awarded contract for constructing sewers in district betw. I and L streets, and 19th and 20th streets, at $11,000.

Cal., Hanford—C. E. Blanchard Co., San Francisco, awarded contr. for constructing 12-in. pipe storm sewer and 6-in. rein. conc. sewers 4 ft. 6 in. wide and averaging 12 to 24 in. in height in portions of Bush, Douty, Ivy and other strets, at $85,961.

Ill., Mt. Vernon—W. S. Shockley, Fairfield, awarded contract for laying sewer in Dist. No. 4, southwest part of city, at $20,934.

Ia., Dexter—City let contracts for bldg. sewers in J. L. Hansman, 48th & Franklin Sts., Des Moines, to total cost of $59,-396; sewage disposal plant, to F. H. Christenson, Guthrie Center, at $12,465.

Ia., Madrid—Dearborn Constr. Co., Waterloo, awarded contract for furnishing and laying abt. 40,000 ft. 8-12 vitr. pipe, at $94,320; Ward and Weighton, 516-17 Davidson Bldg., Sioux City, contr. for bldg. sewage disposal plant, at $38,125.

Iowa, Monona—Hamman-Kruse Constr. Co., Spencer, awarded contract for sanitary sewer system, at $88,101.

Ia., Spencer—P. N. Kruse awarded contract for constructing east side sewer, at $98,860. Contract calls for 3,862 ft. 36-in. sewer; 732 ft. 33-in., 366 ft. 10-in., 732 ft. 24-in., 355 ft. 18-in., 1,808 ft. 15-in., 4,120 ft. 12-in., etc.

Iowa, Stanton—Henry Rees & Sons, Quincy, Ill., awarded contr. for main and lateral sewers, at $32,609; Harness Bros., Ottumwa, Ia., contract for sewage disposal plant, at $34,240.

Iowa, Tabor—Dunnegan & Briggs, Shenandoah, Iowa, awarded contr. for main and lateral sewers, at $39,747; Ward & Weighton, Sioux City, Ia., contract for sewage disposal plant, at $17,560 and $50.00 per cu. yd. for extra concrete. Theo. S. DeLay, Consit. Engr., Creston, Iowa, engineer for above named Iowa projects.

Mass., Boston—West Roxbury Trap Rock Co. awarded contract for bldg. Stony Brook conduit, Sec. 10, West Roxbury, at $109,052.

Minn., Benson—E. T. Webster, St. Paul, awarded contract for constructing proposed trunk line sewer, at $65,665; also contr. for constructing laterals on 9th, 11th and 16th streets north, and on 12th and 14th sts., south—16½ blocks, at $29,-359—total contract price for both trunk line and laterals, $95,025.

Mo., Kansas City—M. Walsh & Son, awarded contract to construct storm and sanitary sewer in 63rd St. and Rockhill road westerly to Oak St. and Meyer Blvd., at $19,000.

Mont., Baker—Two Miracle Concrete Co., 437 Ford Bldg., Great Falls, awarded contract for sanitary sewer mains, at $110,000.

Mont., Bilings—E. Lindstorm awarded contract for installing 8-in. sanitary sewers betw. 28th and 21st streets south; Fifth and Sixth avenue south; two blks. in State Realty Addn., etc., etc., at total cost of about $14,000.

WATER SUPPLY AND PURIFICATION

Ark., Searcy—P. T. Huff, Little Rock, awarded contract for deep well, which will cost not less than $5,000 and not more than $10,000.

Ariz., Phoenix—City let contract for furnishing materials and laying 32 mile 36-in. redwood stave pipe line for Verde Gravity Water System to Redwood Mfg. Co., Pittsburgh, and Pacific Tank and Pipe Ct., Trust & Savings Bldg., Los Angeles, at $845,000 (equally divided).

Cal., Burlingame—Simonds Machinery Co., 117 New Montgomery St., San Francisco, awarded contract by City Trustees for furnishing and installing two pumping units, at $11,110.

Cal., Los Angeles—Lacy Mfg. Co. awarded contract for furnishing Bd. Pub. Service with 1,500 tons 24-in. riveted steel pipe for new water main from Vermont to Main on 11th and 12th streets. Main will cost $125,000.

Cal., Visalia—Supvrs. have authorized Chrmn. and Clk. of Board to sign contract with Thomas Haverty Co., Los Angeles, for constructing water system at Alpaugh in water works district No. 1. Cost will be $17,938.

Colo., Fleming—Orman Constr. Co., Pueblo, awarded contract for bldg. water works system here, at $25,722.

Ind., Bluffton—C. S. Brinnaman, City, awarded contract for two wells and water mains, at $48,660.

Mich., Detroit—J. Porath, 34 McGraw Bldg., awarded contract for furnishing labor and material for laying 20,930 lin. ft. 48-in. steel pipe line, at total cost of $668,-504.

Mich., Grand Rapids—Zomer & Clemens, awarded contract for laying water main in 7th Street—Broadway to Turner Aves.—and in Webster St.—Broadway to Scribner Aves., at $1,072.60.

Mich., Muskegon—Allis-Chalmers Co., West Allis, Milwaukee, Wis., awarded contract for furnishing and installing 15,-000,000-gal., reciprocating pump for water works, at $64,900.

Minn., Hopkins—McCarthy Well Co., Wabash and Eustis Sts., St. Paul, awarded contract for digging artesian well and installing equipt., at about $8,500.

Miss., Charleston—Kirkpatrick & Candy, Florence, awarded contract to enlarge water and sewer systems. 200,000 gal. conc. reservoir will be constructed, along with the other impvts.

Mont., Baker—Two Miracle Cement Co., 342 Ford Bldg., Great Falls, awarded contract for water works system in Impvt. Dist. No. 13, at $14,000.

Mont., Stevensville—Standard Constr. Co., Golden Rule Bldg., Bozeman, awarded contract for bldg. new reservoir and extensions to water works system, at $14,202.

Neb., Auburn—J. H. Dousman, Kansas City, awarded contract for installing pump at water plant, at $1,684.

N. D., Cooperstown—Following contracts let: Water supply system to W. D. Lovell, 1415 SE 8th, Minneapolis, $82,000; 18,000 ft. cast iron water pipe.

O., Toledo—J. Stewart & Co., 30 Church St., New York City, awarded contract for bldg. 1 sty. 30x52 ft. conc., steel and brk. pumping station, at about $25,000.

Okla., Picher—Quapaw Supply Co. awarded contract for meter boxes to supply entire city, at $3.25 each.

S. C., Denmark—W. Z. Williams Co., Macon, Ga., awarded contract to construct water works, at $50,000.

Tex., Dublin—Jno. W. Lacy, City, awarded contract for constr. of 100,000-gal. capy. concrete reservoir for city.

Wash., Seattle—F. Agostino, 1335 21st St. So., awarded contract for bldg. water mains in Nickerson street, involving 2,956 ft. 8 and 20 in. cast iron pipe, at $34,338.

PROSPECTIVE WORK

ROADS AND STREETS

Ark., Little Rock—Petition circulated for impvt. district covering practically all streets from Woodlawn avenue thru hill on which St. Mary's convent is located at Pulaski Heights.

Ark., Little Rock—West Seventh St. will be resurfaced with asphalt. Est. cost $45,-000.

Ark., Mineral Springs—Commrs. Road Impvt. Dist. No. 1 will construct 15 miles of hard surfaced roads.

Ark., Pine Bluff—City will pave 25 blocks of streets; $65,000 to $70,000 bonds. H. C. Fox, Chrmn.

Cal., Los Angeles—A new boulevard will run along east side of Pacific Electric right-of-way to its junction with Redondo Blvd. at Harbor City, from which point to San Pedro the rights-of-way have already been secured.

Cal., San Diego—Plans for paving Chatsworth Blvd. and portions of Catalina and Voltaire streets approved by City Council. This action considered sufficient to make available the $76,000 appropriation by war department for paving Rosecrans street inside military reservation.

Cal., Ventura—E. M. Lynch, Central Bldg., Los Angeles, retained by City Trustees to prepare plans and specfs for Warrenite paving on Poli, Santa Clara, Meta, Spruce and Front streets. Petitions for paving Buena Vista and Crimea streets also expected.

D. C., Washington—Resurfacing of 16 streets authorized by Commrs. at board meeting. Work will be started as soon as weather permits. Total cost of the impvts. $139,900.

Ill., Bloomington—Two ords. passed by Board Local Impvts.; one for impvt. of Monroe street betw. East and Roosevelt streets at est. cost of $20,499; also alley running east and west in blk. bounded by Front, Prairie, Grove and East streets, at cost of $1,450.

Ill., Decatur—City Engrs. have prepared ests. of cost of part of the Eldorado street brick paving project and figures show total of $273,717. This is only for paving from Van Dyke street on west to 3rd street on east side of town. Wood street project, already turned in, is estimated at $210,000 which will bring total cost of paving so far figured, to $500,000. Number of other streets being considered and on which estimates are being prepared will come before Council at next meeting.

Ill., Moline—Fricks Hill, Sixteenth street south of Prospect Park, is to be paved this summer. Specfs. adopted by Bd. Local Impvts. for paving the hill with brick. Est. cost, $13,800. City Engr. Lyle Payton. Board also adopted 5 other paving projects. Brick pavement for 27th street—16th to 23rd avenues, was included. This impvt. will cost $25,000. Other impvts. are: 26th street—11th to 12th Ave., at cost of $14,012; alley betw. 13th and 14th streets—7th to 12th at $5,820; 11th Ave. B—23rd to 24th streets and several short intersecting thoroughfares, $12,353; 17th Ave.—27th street to west line of Forest Hill addition, $3,759.

Ill., Mason City—Mason City will put in about 7 blocks of paving to cost about $48,000.

Ind., Alexandria—Monroe Twp. has voted in favor of issuing $90,000 worth of bonds for paving with cement the Alva Carrol Road.

Ind., Ft. Wayne—Confident that the state tax board will approve a $76,000 bond issue now pending. Board of Works will take up resolution for paving of 32 streets. Few remorstrances are expected.

Ind., Salem—New estimates have been filed and approved for improving the Pekin and Halo roads in Pierce Twp. at cost of $16,422; the Mt. Carmel in Vernon and Howard Twps., at $42,557. Eli E. Batt, Co. Aud.

Iowa, Atlantic—Council has decided to pass resolution to pave about 40 blocks of unpaved streets here.

Iowa, Davenport—Following streets have been ordered paved: Portions of 13th, Sheridan, 6th, LeClaire streets. Resolutions calling for repaving of following streets adopted: Portions of Harrison, First, 2nd, and sections of about 11 alleys; Essex Lane—McClelan Blvd. to Forest road; Central Park Ave.—Arlington to Tremont Avenues and Davenport Ave.—29th to 32nd streets.

Iowa, Estherville—Resolutions for paving passed by Council. Work divided into four sections which embraces approx. portions of 26 streets. All connections to gas, sewer and water mains on said streets shall be made and constructed before May 1st. City Clk. ordered to publish notice to property owners as provided in Ord. No. 188. Jno. G. Smith, Clk.

Iowa, Sioux City—Ord. calling for 3½ miles concrete paving passed by City Council. Sections of South Ave., Ninth Ave. and Dakota Ave. will be paved.

Kans., Wellsville—City Council has issued order deeming it necessary to grade, curb and pave Main street of town from No. line 4th street to So. line 8th street. Plans and specfs. wil be decided on later. Shockley Engineering Co., Kansas City, retained as engineers.

Ky., Lexington—Commrs. of Public Works McCorkle plans to improve Euclid Ave. Thoroughfare will be made into an asphalt boulevard 30 ft. wide (type C asph.). Several streets in Horr Pk. addn. extending west from So. Limestone will also be improved this year. E. 6th St.—No. Limestone to Shropshire Ave.—will also be improved.

La., New Orleans—State has decided to go ahead with the constr. of the Chef Menteur Road, which will cost approximately $360,000. It is also planned to construct the New Orleans-Hammond Hwy. Duncan Buie, State Hwy. Commr.

Maine, Augusta—Authorization to issue bonds for $2,500,000 for highway and bridge construction was given state treasurer by Governor and Council.

Mich., Battle Creek—Resolutions passed by City Comn. provided for purchase of

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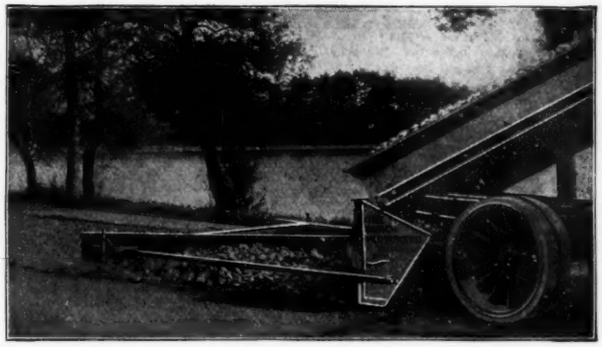

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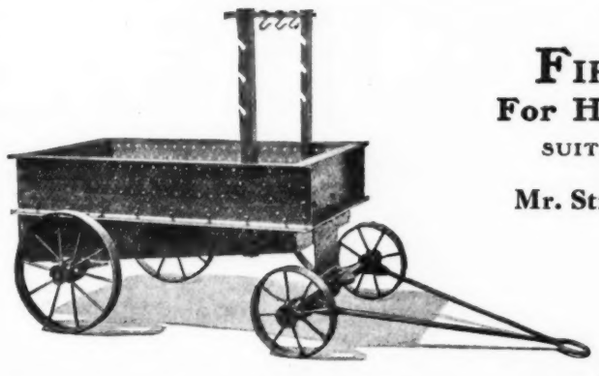

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Mich., Bay City—Bd. Pub. Wks. has decided to recommend to Council the constr. of a 32-ft. pavement on Wenona Ave. from so. side of Midland to intersect. of Henry street. Est. cost of impvt. including space betw. railway tracks, $93,222.

Mich., Shelby—Federal Reward cement road will replace 20 miles of road along West Michigan Pike, to cost $30,000 per mile.

Minn., Duluth—City Commrs. will order First street paved from 30th Ave. to Chestnut street, from 1st to 3rd. Est. cost $13,272.

Minn., Duluth—It is planned to improve Congdon North Shore Blvd. of 13 miles, 1st 5 miles in city limits to be improved by city and 8 mi. out of city to be improved by Lake County.

Minn., Minneapolis—Board Park Commrs. have approved plans for paving Linden Hills Blvd. and King's Hwy. Total cost $110,175.

Mo., Kans. City—New paving propositions adopted were as follows: Sheet asph. pavement on Forest Ave.—22nd to 23rd streets; repave Woodland Ave.—15th to 17th streets; vibrated conc. pavement Euclid and Garfield Aves.—26th to 27th streets; bitum. macadam paving 59th street—Swope parkway to Spruce Ave. Board also voted to repair and maintain conc. and wooden block pavement on McGee street traffic way from Robert Gilham road to Pershing road.

Mo., Kennett—Board of Aldermen passed resolutions to pave the public square and 8 of the principal streets leading up to the square; 2½ miles. Weatherford & Harris, Memphis, employed by the Board to prepare plans and specfs. and to make prelim, estimates.

Neb., Ainsworth—Resolution passed by Council creating impvt. distr. embracing all of Second street not included in Dist. No. 3. New district runs from Pine to Walnut streets and from alley in rear of National bank to Osborn street.

Neb., Aurora—New petition for another paving district accepted by Council. There is to be 13 blocks of paving in district.

Neb., Madison—New paving district created comprising abt. 25 blks. Engr. Wm. Steckelberg will make survey of proposed district and Council will then ask for bids.

Neb., Omaha—Proposed widening of Harney street—20th to 24th streets—will cost $187,475.

Neb., Red Cloud—City Council has passed ord. adding 45 blocks to be paved. Will take altern. bids on cement and asphalt concrete paving.

N. Y., Albany—City considering repaving of Washington Ave. on short, but wide stretch, betw. Northern blvd. and Lexington Ave. Proposed impvt. also includes repaving Sprague place with asph. to connect State St. and Washington Ave. City's share of expense estimated at $33,000.

N. Y., Utica—Eight different types of paving material will be provided for in specfs. for paving here this year. They include sheet asph., asphaltic conc., Warrenite, bitulithic, asbestos bitulithic, bitoslag, cement conc., vitr. brk. and stone block. About $200,000 will be expended for paving. Sep. bids will be asked on grading, foundation and wearing surf.

N. J., Camden—Total of $350,000 worth of paving and repaving, totaling more than 5 miles of new streets, will be completed this Spring and Summer on a schedule announced by Street Commr. A. L. Sayers. New asph. work to extent of 75,000 sq. yds. is proposed and new street work, including all classes of paving, will cover fully 200,000 sq. yds.

N. J., New Brunswick—It is planned to repave Burnet St.—Hiram to Pence Street. Asher Atkinson, City Engr. Engr. will also prepare plans and specfs. for regulating and paving Abeel St.—Commercial Ave. to Oliver St.; Townsend St.—Lee to Commercial; Powers St.—Livingston to Remsen; Lee—Welton to Suydam; Hale—Livingston to Codwise; Comstock St.—Livingston to Codwise, Sanford St.

N. D., Minot—City Commrs. will construct 4½ miles of paving. Total cost, $525,000.

Okla., Ada—Bd. of Commrs. have passed resolutions for paving 125 blks. in business and residence districts. Approx. cost, $750,000. Johnson and Benham, Cons. Engrs., 8th Flr. Firestone Bldg., Kans. City.

Okla., Chickasha—$200,000 bonds voted to pave ten miles of various streets. Engineer not selected.

Okla., Edmond—City considering paving streets; concrete; $250,000. Beckham & Sutton, Engrs.

Okla., Hominy—Majority of property owners on a principal street have signed petitions for 10 blks. of paving extending thru new section of town.

Okla., Lindsay—City contemplates paving 12 blocks in business section; $115,000. Johnson and Benham, Consit. Engrs., Firestone Bldg., Kansas City, Mo.

Okla., Tulsa—Following petitions for street paving, approved by City Engineer, adopted: Portions of So. Wheeling Ave., Quincy Ave., Utica Ave., Gillette Ave., Elwood Ave.

Okla., Walters—59 blocks of street (asphalt) will be paved here.

Pa., Lebanon—Ords. providing for large amt. of hwy. impvts. in 5th Ward passed by Mayor and Council. Included are following streets: 6th—Church avenue to Guilford street; 5th St.—Reading R. R. trks. no. to city limits; 4th St.—Railroad trks. no. to city limits; Puilford street—7th to 8th streets and 4th to 7th streets.

Pa., New Castle—5 repaving projects costing approx. $90,000, make up the city's street impvt. program for this year.

Pa., Pittsburgh—Tentative plans to be considered for a roadway thru "nine-mile run canyon" connecting city with Wilkinsburg, Swissvale and Braddock.

R. I., Providence—Bd. of Aldermen adopted resolution directing City Solicitor to apply to the Legislature for authority for city to hire an additional $150,000 to be used with $200,000 more, for which authority has already been obtained, in laying durable pavements on Westminster and Cranston streets.

S. C., Columbia—45 residents of sections of Barnwell, Pendleton, Laurens and Green streets presented petition for paving of roadways as follows: Barnwell—Gervais to Pendleton; Pendleton—Barnwell to Laurens; Laurens—Pendleton to Green; Green to Harden streets.

S. C., Columbia—Bond issues to amt. of $12,758,000, for construction of highways in state, have been authorized during present session of general assembly.

S. C., Gaffney—At recent meeting of City Council it was definitely decided to pave those streets going to make up principal avenue from city proper to Limestone college. City's share of expense will be approx. $25,000.

Tex., Coleman—$400,000 bonds voted by Coleman County Commrs. for constructing 23 miles of road in Santa Ana Precinct.

Tex., Seymour—City will construct 30,000 sq. yds. street paving; $100,000 available. R. G. Carraway Co., Engrs., Gainesville.

Va., Norfolk—Plans under way for widening of 10 streets here. Cove, Granby and Monticello Ave. will be improved first.

Wash., Creston—Bids will be asked about July 1 for impvt. of 11 miles of road betw. Creston and Peach, Lincoln County.

Wash., Ellensburg — Kittitas County voted bond issue of $50,000 to pave 3 miles betw. Cle Elum and Roslyn. Balance of cost will be paid out of road district funds.

Wash., Pullman—Resolution adopted by Council to pave 17 blocks (approx. 11,000 running feet) on Methodist Hill.

Wash., Raymond—Passing of the $162,000 bond issue by Pacific County means the expendt. of $90,000 betw. Raymond and Lewis County line, and remainder so. of South Bend, all of which is planned for this year.

Wash., Seattle—Estimates of cost of paving proposed new Vashon Island Hwy. are being made by Principal Asst. Co. Engr. Carl E. Morford. Hwy. is 11 miles long and probable cost is figured at not less than $375,000. New hard surfaced road would run from north to south of the island.

Wash., Seattle — Plans completed by County Engr. for new lateral hwy. one mi. north of no. city limits—about 3 miles. Est. cost $45,000. Bids will be called for shortly after plans are approved.

Wash., Spokane—City Council of Pullman has passed resolution authorizing paving of 11,000 ft. streets here. Bids will be advertised as soon as engineer's plans are completed.

W. Va., Bridgeport—Town will construct brick road 20 ft. wide; conc. base; $25,000 available. J. R. Wilson, Co. Engr.

Wis., Chippewa Falls—Federal road 227 miles long will be improved in Chippewa County.

SEWERAGE AND SEWAGE TREATMENT

Ala., Birmingham—City considering plans for constr. of an elaborate system of storm sewers to cost more than $1,000,000. Julian Kendrick, City Engr.

Ark., Little Rock—First steps taken for organization of an impvt. district for purpose of bldg. big conduit to serve as outlet for sewerage of 19 districts and 6 private districts in western part of city. Est. cost of impvt., $150,000.

Cal., El Cerrito—City Trustees plan to sell $80,000 bonds to cover cost of bldg. vitr. storm sewerage system. W. S. Farley, City Engr.

Cal., Glendale—Olmsted & Gillelen, Cons. Engrs., Hollingsworth Bldg., Los Angeles, have filed with the City Mgr. their report on the proposed sewer system for city, including plan of sewage disposal. Entire system will cost about $500,000. Bond issue of $250,000 will be required for main sewers, interceptors and disposal plant.

Colo., Fort Collins—City has established 2 new storm sewer districts which will involve expendit. of $319,000. An area of 108 blocks is included in the two districts.

Colo., Greeley—Plans under way for complete system of storm and sanitary sewers. Est. cost of constr. $300,000. Burns & McDonnell, Cons. Engrs., Kans. City, Mo.

Conn., Wethersfield—$100,000 appropriated by City for construction of sewers.

Ill., Decatur—Miller, Holbrook, Warren & Co. preparing comprehensive report on sewers for the Johns Addn., East Decatur, and northern sect. of city from Chamber of Com. addn. west to Stevens Crk., to take care of present and future needs. Engineers suggest constr. of double sewer system along edge of proposed water impounding lake.

Ill., Rochelle—Town of Mt. Morris considering installing an up-to-date sanitary sewerage system for purpose of relieving present insanitary conditions. Water supply endangered.

Ind., Anderson—Engr. Claussen's estimate of cost of new sewer system is $949,929. Engineer's plans call for abt. 1 mile 8-ft. sewer; nearly 1 mi. 7-ft.; ½-mi. 3½-ft.; 1 mi. 3-ft.; ¾-mi. 24-in. and ½-mi. 18-in. Est. also provides for 95 manholes, 249 catch basins, 6 extra catch basins, one special intake basin and one bulkhead. Extension of line of trunk sewer into Jackson Pk. will also be included in contract.

Ind., Hammond—City's proposed new sewage pumping station has received approval of Board of Public Works. Station will be located on tract of approx. 12 acres in Columbia Ave. just no. of river, and will cost, together with north and south side sewers, about $1,000,000. Station will include power house bldg. complete with receiving chamber and two screen chambers, heating plant, traveling crane and concrete walks.

Ind., Logansport—Constr. of new sewer system, affecting southwest section of city, is being considered. City Engr. H. Bell will start work in near future of preparing estimate of cost of constr. Residents of this section of city in favor of the sewer.

Ind., So. Bend—Resolutions for constr. of sewers on Douglas, Webster, Bruce and Oliver streets, adopted by Board of Public Works at meeting.

Iowa, Durant—Price & McCormack, Missouri Valley Engrs., retained for sewer construction. Est. cost $75,000. Paul Sanberg, Town Clk.

Ia., Sac City—Resolution adopted by Council to construct vitr. clay pipe sewers, manholes, lampholes of brk. or conc., etc., on Audubon St. (8-in.); 14th St. (8-in); 12th St., plat, Leonard, Sixth, Duncombe, Phelps, Ongersoll, North and South alley in Blk. 35, Beck, Guy & Platt's Addn., and alley in blk. 27, Platt's Addn.—all 6-in. Plans and specfs. by W. L. Fahey, Spencer, Ia. Wesley Gilbert, City Clk.

Kans., Garden City—City contemplates constructing sewers as follows: 24-in. sewer on 8th street—Grand avenue under r. r. tracks to Maple street, and east on Maple to Main street and from that point to river in open ditch. From 8th street a branch to run west to 9th and eventually to 10th street when street is paved.

Kans., Hutchinson — 13 new sanitary sewer laterals provided in ord. placed on 1st reading at meeting of City Comm. Resolution placed on 1st reading providing for another sewer to be known as Grandview industrial sewer, sub-main No. 1. This is located in extreme eastern section of city.

Ky., Louisville—Work of extending city's sewerage system will begin at once. Geo. T. Wood, Chrmn. of Sewer Comm., which

will have at its disposal proceeds of $2,000,000 bond issue voted last November.

Mass., Brookline (Boston, P. O.)—Town having plans prepared for bldg. sewers. About $90,000. H. F. Varney, Town Engr.

Md., Aberdeen—City contemplates constr. of sewage disposal plant. May issue $100,000 bonds.

Minn., Minneapolis—City Council will consider program prepared by Carl Illstrup, City Engr., for apportionment of approx. $450,000 among 9 of the 13 wards in city for sewer constr.

Mo., Joplin—City plans sewer extensions to cost approx. $288,000.

Mich., Muskegon—City Mgr. Ellison will start work on Market street sewer as soon as it is possible to do so.

Mont., Melstone—Resolution passed by Council to complete sanitary sewer system at cost of about $40,000. Claude E Ranshaw, Roundup, Engr., instructed to proceed with the work.

Neb., Shelton—City contemplates constr. of san. sewer system. F. A. Kimbrough, Vil. Clk. Est. cost $30,000.

N. J., Dover—City voted on $450,000 bonds for constr. of sanitary sewerage system. G. Jenkins, Dover, Engr.

N. J., Highland Park—Borough Council has passed ord. for issuance of $75,000 worth of storm sewer improvements.

N. J., Perth Amboy—Ord. appropriating $7,000 for laying sewer in Laurie St. from Groom to New Brunswick Ave. and from Penn to easterly terminus of Laurie St., has been passed.

N. J., Pleasantville—City Council has decided to install water works type of disposal plant as designed by City Engrs. Remington and Vosbury. Plan is to have pipe line run into beach thoroughfare. Proposed plant will cost approx. $85,000 to install and will pump about 1,000,000 gals. sewerage daily.

N. J., Westville—Plan for sewer system is being worked out by Boro. Engr. at direction of Westville Council, which is expected to take some definite action concerning the impvt. at next meeting.

N. C., Greensboro—Proximity Mfg. Co.—B. M. Cone, Pres.—contemplates installing sewer system for 2,000 houses in Proximity, Revolution and White Oak cotton mill villages. Gilbert White, Engr.-Archt., Durham, N. Car.

N. D., Halstad—At recent election in village favorable vote cast to install system of sewers. Est. cost about $14,000. Of this sum $6,000 has already been raised.

Ohio, Akron—Plans being prepared for new sewer on W. Exchange St.—Bowery street to the cemetery. City estimate shows new sewer will cost about $16,800.

Ohio, Dayton—Plans for impvt. of sewer system in Dayton View and Riverdale, whereby mains will be laid to take care of the sewerage of 1920 are under consideration by City Comn. Impvt. will cost approx. $100,000, to be derived from proceeds of April bond issues.

Ohio, E. Cleveland (Cleveland P. O.)—City having plans prepared for bldg. storm sewers in E. 131st St., involving 3,000 ft. 18-24 in. vitr. pipe, 8 manholes, etc. Cost to exceed $10,000. M. Garnett, City Hall, Engr.

Ohio, Hamilton—Petitions for sewers in sections of about seven streets presented to Council.

Ohio, Miamisburg—Cellarius & Dresser, Sanitary Engrs., Dayton, engaged to prepare plans and specfs. for sanitary sewers here.

Ohio, Newburgh Heights (Cleveland P. O.)—Village will receive bids about June 1st for bldg sewers and water mains East 41st, Bridgeview and Alpha avenues, involving 8-20 in. vitr. pipe, 6 and 8-in. cast iron pipe, 10 manholes, etc. Abt. $30,000. R. Hecker, 905 Leader News Bldg., Cleveland, Engr.

R. I., Newport—$10,900 appropriated to construct sewers in various streets. S. J. Easton, City Engr.

S. D., Canova—Arrangements being completed for installing sewerage system in Canova, at cost of $25,000.

S. D., Humboldt—Movement for installing an up-to-date sewerage system here inaugurated by local Commercial Club. Town Board is expected to take early action in matter.

Tex., Dallas—Citizens of Mill Creek district—Cano street on no. and Beaumont and Rowlett street on south and east—want Mill Creek converted into storm sewer, leaving surf. available for thoroughfare. Petition calls attention of Bd. of Commrs. to fact that new public school is being erected adjacent to the creek. Creek is unsanitary and offensive to the eye in its present state.

WATER SUPPLY AND PURIFICATION

Ariz., Phoenix—City Mgr. V. A. Thompson has signed contracts with Pacific Tank and Pipe Co. and Redwood Mfg. Co. for 153,900 ft. 36-in. Redwood stave pipe for Verde gravity water system. Bids will be asked in near future for excavation, intake work and incidentals. About $450,000 of the bond issue remains for this work.

Ariz., Prescott—J. W. Waaram, Engr., Prescott, retained by City Council to prepare plans for storage part of new water works system. Work includes conc. and earth dam and reservoir, wood pipe lines, cast iron mains, etc. J. H. Robinson, Clk. $350,000 bonds voted for impvt.

Cal., El Centro—City Trustees have decided on bond issue of $195,000 for constr. of new river settling basins and conc. lined aqueduct; also an issue of $28,000 for concreting the present settling basin.

Cal., Monrovia—City Engr. H. S. Gierlich preparing plans and specfs. for impvts. to municipal water system under the $90,000 bond issue recently voted. These include a 1,000,000 gal. unit of a new two million gal. rein. conc. reservoir, new deep wel's and pumps and new mains.

Cal., Ontario—$40,000 bonds voted to sink another well and install pumping equipt. at Fourth Street pumping plant. $15,000 also voted to purchase 90-acre tract for water development.

Cal., Williams—Prelim. plans being prepared for water wks. system and sewage disposal plant. About $22,000 and $18,000 respectively. Elec. soon to vote on bonds for project. A. Givan, Forum Bldg. Sacramento, Engr.

N. Y., Tonawanda—Supt. Frank E. Chase urges installation of meters throughout the city.

O., Point Place—$185,000 bonds for water system has been sold.

Va., Bedford—$150,000 bonds voted by city for improvement of water works and hydro-electric plant.

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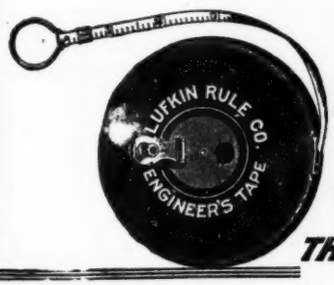

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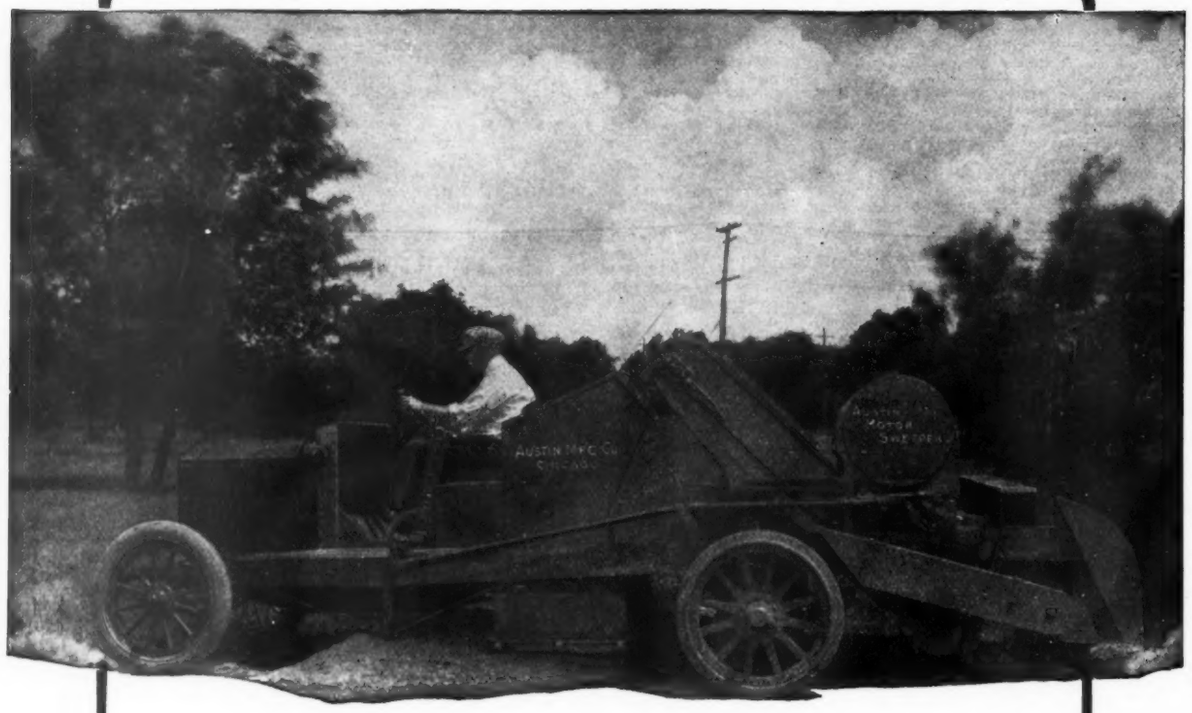

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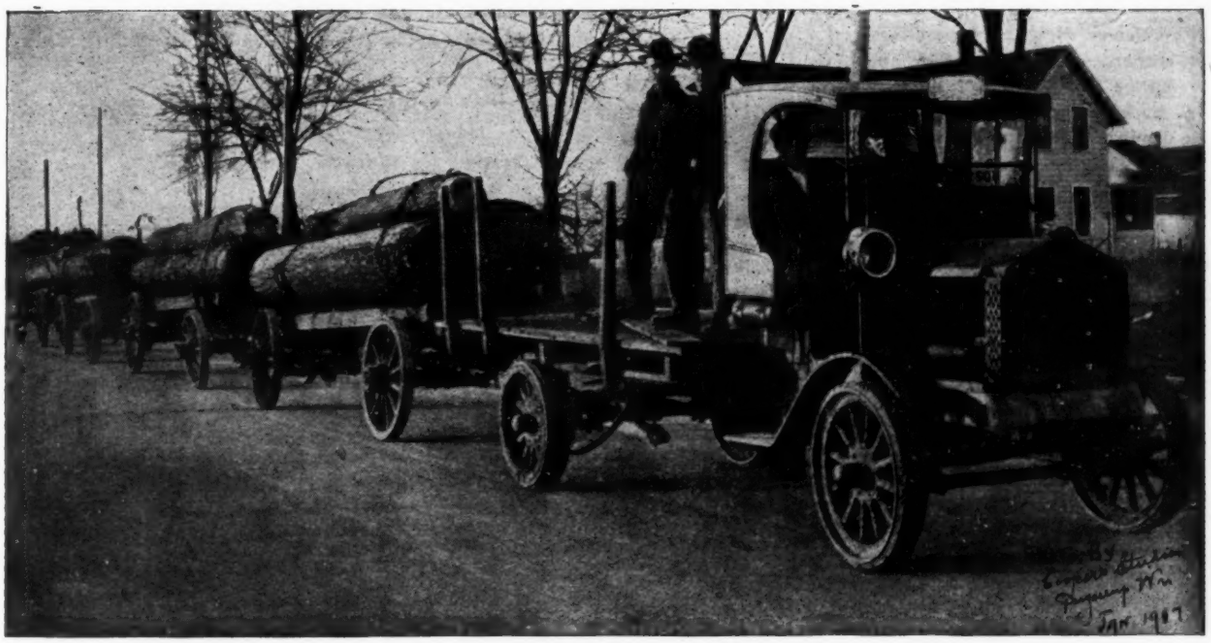

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